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Across Early Policy and Market Contexts Women and Men Show Similar Interest in Electric Vehicles

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A Research Report from the National Center for Sustainable Transportation

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16. Abstract

While ownership and purchase of all vehicles approach gender parity, to date electric vehicles (EV) are being purchased by far more men than women. Prior analysis from California finds no reason in the available data why this difference persists. This report extends that analysis across 12 other U.S. states with varying, but generally less supportive than California, EV policy and market contexts. Data are from a survey conducted of new-car buying households at the end of 2014, which allowed participants to express their prospective interest in acquiring an EV. Participants then indicated why they were motivated to select an EV or what motivated them to not select one. Via multivariate modeling, differences in prospective interest in EVs between female and male respondents are examined, and overall, no difference rises to the level of the observed differences in real EV markets. Further, the multivariate modeling indicates no statistically significant effect of a sex indicator on prospective interest almost anywhere in these data; where there is a difference, female participants are estimated to be more likely to select an EV than their male counterparts. While participants from both sexes tend to give high scores to the same EV (de)motivations, differences in their rank orders repeat generalizations from other research. On average, female respondents score environmental motivations for selecting an EV higher than do male respondents. On average, male participants score interest in "new technology" as a motivation for selecting an EV higher than do female participants. Conversely, on average female respondents who do not select an EV score "unfamiliar technology" more highly than their male counterparts. Within the variation in EV policy and market contexts represented in this study, no finding here explains why similar prospective interest in EVs from five years ago has yet to be turned toward equal participation in EV markets. Explanations may lie in factors not modeled here.

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Disclaimer

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NCST

Across Early Policy and Market Contexts Women and Men Show Similar Interest in Electric Vehicles

A National Center for Sustainable Transportation Research Report

August 2021

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EXECUTIVE SUMMARY

This study analyzes the role of gender in prospective interest in electric vehicles (EVs) in the U.S. states of Oregon (OR), Washington (WA), Delaware (DE), Massachusetts (MA), Maryland (MD), New Jersey (NJ), and New York (NY). Further, the states of Connecticut (CT), Maine (ME), New Hampshire (NH), Rhode Island (RI), and Vermont (VT) join NJ, NY, and MA as members of the Northeast States for Coordinated Air Use Management (NESCAUM) for which a regional analysis is also conducted. Further, it reprises a similar analysis of data from California (CA), results of which are referenced here to support conclusions across varying EV policy and market contexts.

In contrast to the near-parity between women and men observed in household purchases of all light-duty vehicles, far more EVs had been sold to men than women across the U.S. since the advent of EV sales at the end of 2010, up through the period of data collection in late-2014, and on to the present. Prior analysis within the EV policy and market context of California circa-2014 found no difference in prospective interest in EVs between women and men living in households that buy new vehicles. As California has the most comprehensive policy program to encourage EV markets and as it has by far the largest EV market share of any U.S. state, the question arises as to whether prospective interest in EVs is different in states with some, but fewer, supporting policies and smaller markets.

"Gender" results are based on inferences from analysis of a binary sex distinction: female-male. The survey allowed respondents to select female, male, to self-identify, or to decline to answer. Of more than 5,600 respondents only 25 chose either of the last two options. This is not to dismiss the importance of these 25 people, but to indicate the absence of a more refined scale of what constitutes "gender." Therefore, the analysis uses the binary sex distinction and any differences between "female" and "male" participants would then be construed as "gender" if those differences reflect socially defined expectations of people who live in a female or male body. That gender represents a continuity—thus illustrating limits of the practice of using sex as a proxy for gender—is evidenced by the result that there is nothing in these data or results that only female or male participants know, believe, do, or want.

This report employs survey data from new-car buyers collected via an on-line survey at the end of 2014. The original state- and region-level reports included the estimation of nominal logistic models on the drivetrain type selected by survey participants in the final round of vehicle design games they play as part of the survey. The design and selection of a plug-in hybrid electric vehicle (PHEV), battery electric vehicle (BEV), or fuel cell electric vehicle (FCEV) is taken to be a positive prospective interest in EVs. Participants who selected a conventional internal combustion engine vehicle (ICEV) or hybrid electric vehicle (HEV) express either a negative or no positive prospective interest.

No result here regarding prospective interest in EVs suggests that if those interests were being fulfilled then anything like the skew toward male buyers that existed at the time these data were collected in late-2014 could be sustained as they have been to the present. Further, it can be concluded that while the observed differences in overall interest in EVs among new car buying households correspond to state policy and market contexts, differences between female and male participants do not. Across all state and regional analyses (including the prior analysis of California) 20 to 39 percent of female participants designed a PHEV, BEV, or FCEV as their next new vehicle, while 27 to 42 percent of male participants did the same. The percentage of all respondents in each state or region who select an EV does correspond with policy and market conditions; higher percentages of participants from west coast states which had more policy support (CA in particular) and earlier market activity (including OR and WA) select EVs than in any east coast state. Thus, while it is generally true across all policy and market contexts observed here that slightly more men than women appear to show a positive prospective interest in EVs, nowhere does this difference rise to the level the disparity in actual EV sales—at that time or today. Overall, relative prospective interest between women and men was similar regardless of policy or market context.

New York (NY) and NESCAUM are the only places where the models of prospective interest in EVs contain a statistically significant variable for participant sex. Elsewhere, the multivariate modeling indicates that controlling for several other variables any apparent difference between female and male participants in prospective interest in EVs is due to other causes. The result for NY and NESCAUM is an interaction term between the participant's sex and another explanatory variable is statistically significant. For NY, the interaction is between participant's sex and monthly miles of driving. For the NESCAUM region, the interaction is between the participant's sex and their evaluations of the safety and reliability of BEVs and PHEVs compared to conventional gasoline vehicles.

Given their vehicle designs, participants scored motivations for or against designing an EV. For each motivation and each state (or region), tests were conducted on whether the mean scores differed between female and male participants. The statistically significant differences are in the same direction in every state and region. For example, on average female participants who select an EV score, "reducing the effect of my driving on climate change," higher than do their male counterparts. This difference is statistically significant in four states; nowhere do male respondents, on average, score this motivation higher than female respondents. Conversely, male respondents in four states and across the NESCAUM region who select an EV score "interest in [Z]EV technology" higher than do their female counterparts; nowhere is the mean score for female participants statistically significantly higher than for male participants. Participants who selected a conventional or hybrid vehicle scored the statements "limited [electric] charging and [hydrogen] fueling systems" as well as "high vehicle purchase cost" as motivations to avoid EVs. Among those who did not select an EV, there are almost no statistically significant difference between female and male respondents as to why they did not.

Introduction

This report extends results of prior research into the role of gender in the early electric vehicle (EV) market in California (CA) [1]; it is intended as a companion piece to that earlier analysis. The extension is to several U.S. states all with fewer EV sales (total and shares) and with fewer supporting policies than CA, especially in late-2014 when the household data were collected. These other states are Oregon (OR), Washington (WA), Delaware (DE), Massachusetts (MA), Maryland (MD), New Jersey (NJ), and New York (NY). Further, though there are no individual state-level analyses for them the states of Connecticut (CT), Maine (ME), New Hampshire (NH), Rhode Island (RI), and Vermont (VT) join NJ, NY, and MA for analysis of the region encompassed by the Northeast States for Coordinated Air Use Management (NESCAUM). NESCAUM makes no regional policy and does not represent a distinct policy context. For example, not all its member states were, or are, Section 177 states, i.e., they have not all adopted CA's air quality standards. Still, as the available data were designed to allow a regionwide analysis and as NESCAUM-member states CT, MA, NY, RI, and VT joined CA, MD, and OR to create a Multistate Zero Emission Vehicle (ZEV) Action Plan (and were subsequently joined by another NESCAUM-member state, NJ), analysis across the NESCAUM region is included. For purposes of this analysis, the "early" EV market is taken to be the period from late-2010 through 2014.

This research uses a binary sex identifier (female-male) as a proxy for gender. This decision, and the distinction between biological sex and socially-defined gender roles, are discussed more fully in the report for CA [1]. Results here will be discussed within the narrow definition of the binary sex variable. Any differences between "female" and "male" participants might then be construed as "gender" if those differences reflect socially defined expectations of people who live in a female or male body. That gender may represent a continuity rather than binary categories—and thus illustrates the limits of this widespread practice of using sex as a proxy for gender—is evidenced by the result that there is nothing in these data or results that only female or male participants know, believe, do, or want.

In CA, it was observed that rather than the nearly one-to-one ratio of men-to-women found in the market for all new vehicles, the ratio of men-to-women among applicants for California's Clean Vehicle Rebate (as a proxy for EV buyers) was three-to-one [2]. Additional evidence from the literature and U.S. state vehicle registration data indicates this skew towards men exists in other nations [3] and U.S. states (Figure 1) as well as over time (Figure 2) [4]. To date, much about the EV market in the U.S. is shaped by the fortunes of one EV manufacturer—Tesla. The gender split among owners of Tesla's Model S (available during the early EV market as defined for this study) is now 77 percent male/23 percent female [5]. If it was hoped the subsequent appearance of the more affordable Tesla Model 3 would open the EV market to a wider variety of people, it is not a harbinger of gender equality. The Model 3 has been described as "the most 'male' of the Tesla models": as of early 2019 the gender split of Model 3 buyers was 84 percent male/16 percent female [6].

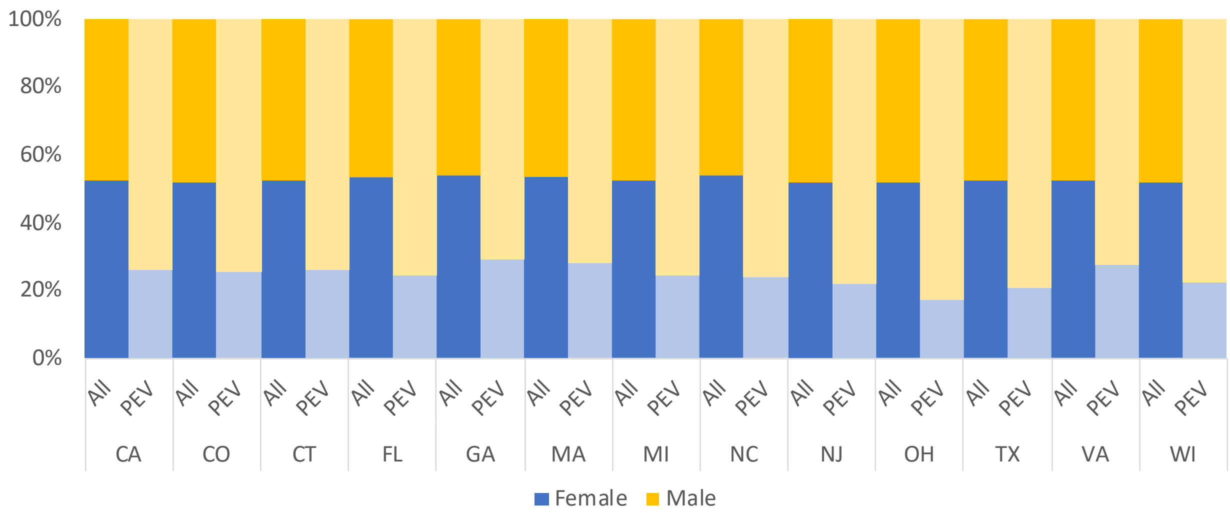

Figure 1. Gender Split among Registered Owners of All Vehicles and Plug-in Electric Vehicles (PEVs) for select U.S. states for 2017 and early-2018, percent female and male

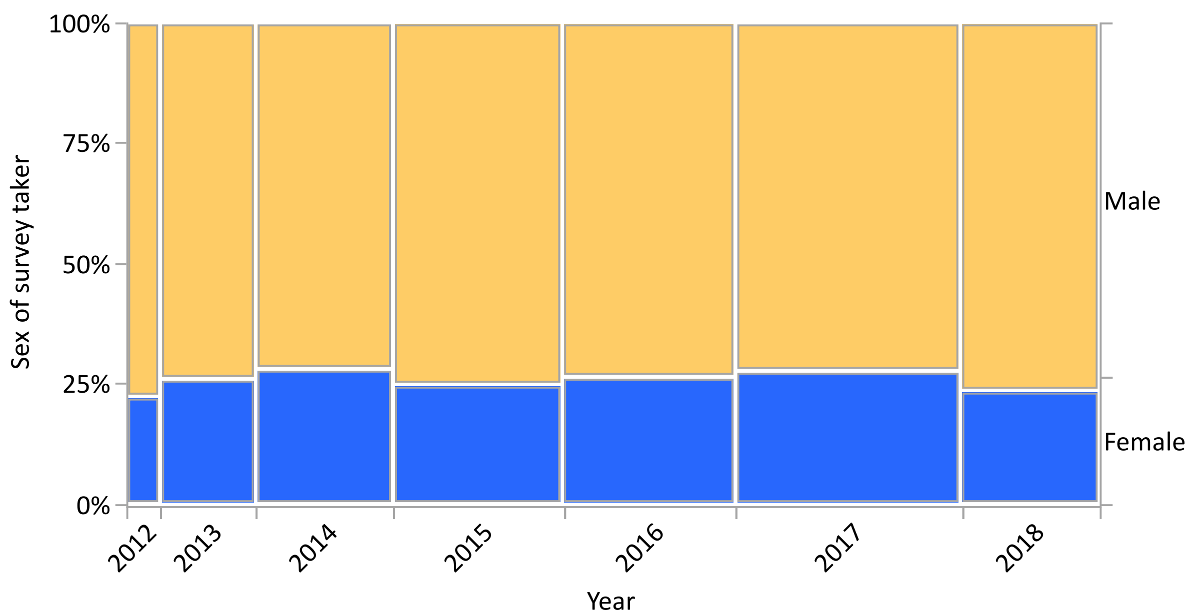

Figure 2. Gender Split in California Plug-in Electric Vehicle Registered Owners from 2012 to 2018, percent female and male

Faced with this evidence of gender imbalance, the re-analysis of the 2014 CA data on prospective interest among all new-car buying households [1] concluded,

> "...female and male participants share similar distributions of interest in the next new vehicle for their household being a [plug-in electric vehicle] PEV or fuel cell electric vehicle (FCEV). For no electric-drive vehicle type did the male-to-female ratio approach that seen in the actual early market for PEVs."

While the early and continuing skew toward men in the market for EVs is clear, what is not is why this skew persists; the prospective look forward in the late-2014 CA survey data shows women and men were similarly interested in their next new vehicle being a PEV [1].

Policy Background, circa late-2014

This background summarizes policies and initiatives to establish markets for EVs in the study states and NESCAUM region at the time data was collected in late 2014. EVs include battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) (collectively, plug-in electric vehicles (PEVs)) and fuel cell electric vehicles (FCEVs)). "Zero emission vehicle" (ZEV) includes PEVs and FCEVs.[1] This review does not provide an up-to-date description of any subsequent ZEV market or policy.[2] This review does describe the contexts in which consumers could have been aware of ZEVs and in which they could have considered or purchased ZEVs at the time their data were collected. Much of this review is excerpted from the initial state reports [7-15] and collected here; references are in those original reports.

The constant across all U.S. states in late 2014 was a federal tax credit for the purchase of a PEV. The credit for PEVs ranged from $2,500 to $7,500 depending on the size of the traction battery. All BEVs for sale in the U.S. had batteries large enough to qualify for the maximum credit, PHEVs generally qualified for a smaller credit. There were limits on manufacturers as to how many of their vehicles would be eligible for the credit but as of late-2014 no manufacturer had sold enough PEVs to be affected. FCEVs did not qualify for this federal tax credit.

State and Regional Coordination

At the time of data collection OR, CT, ME, MD, MA, NJ, NY, RI, and VT had adopted CA's ZEV standards. The ten "ZEV states" signed a memorandum of understanding that, in part, created a ZEV Program Implementation Task Force (Task Force). The Task Force published a ZEV Action Plan (Plan) in May 2014. The Plan listed 11 priority actions, including deploying at least 3.3 million ZEVs—roughly 15% of new vehicle sales in the collective region of the ZEV states—as well as adequate charging and fueling infrastructure by the year 2025. Within three separate sets of states, automakers may apply ZEV credits earned in one ZEV state to their sales requirements in other states so long as a minimum number of ZEVs are sold in each ZEV state.

Northeast States for Coordinated Air Use Management

The Northeast States for Coordinated Air Use Management (NESCAUM) is a nonprofit association of air quality agencies from eight states: CT, ME, MA, NH, NJ, NY, RI, and VT. It was founded in 1967 to address air pollution from power plants in New England. Subsequently, NY

[1] The terms electric vehicle and acronyms EV, BEV, PHEV, PEV, FCEV, and ZEV will be used as appropriate for the context. For example, some policies are named as "ZEV" policies, others as "electric vehicle" or EV policies. The proper names will be used when naming or referring to a specific policy. In the rest of this report the terms BEV, PHEV, PEV, FCEV, and ZEV will be used to refer to the appropriate vehicle type or types.
[2] The US Department of Energy provides an updated state-level description on their Alternative Fuels Data Center site (https://afdc.energy.gov/laws/state).

joined in 1970 and NJ in 1979. It provides analytical, technical, scientific, and policy support across four subjects: climate and energy, mobile sources, policy, and science and technology.

States remain the primary policy making entities and thus there is variation across the region as to laws, regulations, and policies. With respect to ZEVs, all NESCAUM member states except NH are both "Section 177" and "ZEV" states, meaning they have adopted both CA's air quality standards and ZEV requirements. By virtue of the federal Environmental Protection Agency's Cross-Border Sales Policy, no manufacturer of ZEVs is precluded from selling ZEVs (or other "California" certified vehicles) in NH, as it is contiguous with Section 177 states (ME, MA, and VT).

State-level Policies

The state overview starts with CA as its policy provides the framework in which other states' ZEV policies operate and as the analysis of gender in the early car market in CA is a comparison case. CA had and continues to have the most developed ZEV market and policy context of any U.S. state. The nine other ZEV states may or may not have had any state-level policies to promote ZEV sales (beyond their status as a "ZEV state" and membership in the Task Force). The order of presentation reflects a rough classification of state-level policy support and market growth from high to low: CA first, followed by OR and WA by virtue of market size, then eastern states with supportive policies (MD, MA, NY, and NJ), and finally states with lower levels of policy support and market growth (DE and NESCAUM-member states not previously listed).

California

Creating a ZEV Policy Framework

CA adopted a ZEV mandate in 1990 requiring manufacturers of passenger cars and light trucks to sell a certain percentage of ZEVs. This requirement has gone through several modifications in the subsequent 30 years. ZEVs include BEVs and FCEVs; PHEVs are considered transitional ZEVs and are generally included in incentive programs and vehicle requirements in CA. The California Air Resources Board (ARB) determines how many ZEV credits are required to satisfy the mandate each year. Notably, one credit does not equal one vehicle. As of 2014, a BEV earned between one and nine ZEV credits depending on driving range (longer range, more credits). Credits may be traded between manufacturers and manufacturers can meet their sales requirements with a mix of vehicle technologies.

ZEVs Available in California

The PEVs that were or had been available for sale or lease in CA in late-2014 were:

- BEVs: Fiat 500e, Ford Focus BEV, BMW i3, Chevy Spark BEV, Honda Fit BEV, Kia Soul BEV, Mercedes B-Class Electric, Mitsubishi i-Miev, Nissan Leaf, Smart Electric Drive, Tesla Roadster and Model S, Toyota Rav4 BEV and Volkswagen E-Golf.
- PHEVs: Cadillac ELR, Chevy Volt, Ford C-Max Energi and Fusion Energi, Honda Accord Plug-in Hybrid, Mercedes-Benz S550e Plug-in Hybrid and the Toyota Prius Plug-in Hybrid.

- FCEVs (only available to lease and in very small numbers): Honda FCX Clarity, Hyundai Tucson Fuel Cell, and Toyota Mirai.

Some of these vehicles were offered in other ZEV states. However, policy makers and PEV advocates in other states routinely complained of a lack of PEVs offered for sale in their states.

As of June 2015, 49% of the ZEVs sold or leased in CA were BEVs and 51% were PHEVs, compared with the national average of 47% BEVs and 53% PHEVs sold or leased. As of August 2014, approximately 40% of all PEVs sold in the U.S. were in CA. As of August 2015, CA had paid approximately 113,000 Clean Vehicle Rebates (CVR). Most CVRs were for the BEVs and PHEVs listed here. The retail availability of FCEVs was extremely limited; approximately 100 CVRs had been paid for FCEVs.

State, Local, and Private ZEV Incentives

CA ZEV buyers' eligibility for incentives to buy and drive ZEVs varies from the ubiquitously available federal tax credit to quite limited eligibility. Limits on eligibility might be location-based, e.g., where the ZEV driver lives, vendor-based, e.g., what insurance company the ZEV driver uses to insure their ZEVs, or some other limit. As examples, these include:

1. State High Occupancy Vehicle (HOV) Lane Exemption allowed ZEV drivers to use designated HOV lanes regardless of the number of occupants in the vehicles. Vehicles were also exempt from High Occupancy Toll fees. These exemptions were valid for a limited number of years;
2. Alternative Fuel Vehicle Rebate Program offered rebates for the purchase or lease of qualified vehicles via The Clean Vehicle Rebate Project. Rebates were up to $2,500 for those light duty BEVs and PHEVs and $5,000 for FCEVs approved by ARB;
3. Alternative Fuel Vehicle Rebate Program provides a rebate of up to $3,000 for the purchase or lease of eligible new vehicles via the Drive Clean! Rebate Program administered by The San Joaquin Valley Air Pollution Control District;
4. Sales Tax Exclusion for Manufacturers, set to expire June 2016;
5. Alternative Fuel and Vehicle Incentives for businesses, vehicle and technology manufacturers, workforce training partners, fleet owners, consumers and academic institutions to develop and deploy alternative and renewable fuels and advanced transportation technologies;
6. Insurance discount up to 10% from Farmers' Insurance on certain coverages for HEV and alternative fuel vehicle (AFV) owners;
7. PEV Charging electricity rate reductions through The Sacramento Municipal Utility District, Southern California Edison, Pacific Gas & Electric, Los Angeles Department of Water and Power, and San Diego Gas & Electric;
8. Electric Vehicle Supply Equipment Rebate via the Charge Up L.A.! Program administered by The Los Angeles Department of Water and Power. The first 2,000 residential and commercial customers to install a Level 2 240V charger qualify for a rebate;

9. Initially free, now discounted, parking for PEVs in designated downtown Sacramento parking garages and surface lots that are certified by the City's Office of Small Business Development;
10. Free parking in some cities for BEVs displaying a Clean Air decal; and,
11. Many private companies offered Level 1 and/or Level 2 charging to their employees.

PEV Charging Infrastructure

As of November 2015, CA had over 8,300 PEV charge points at 2,755 locations; these were non-residential PEV chargers accessible to the public. CA was part of the West Coast Green Highway project to install DC fast charging stations every 25-50 miles along Interstate 5, running from the Canadian border to the Mexican border.

The EV Project launched in October 2009 using a $99.8 million dollar grant from the U.S. Department of Energy (DOE). In June 2010, it was granted another $15 million by DOE and along with matches, the total value was approximately $230 million. Partnering with Chevrolet and Nissan, The EV Project provided a residential PEV charger at no cost plus up to $400 toward installation cost to qualified participants. In exchange, those receiving a charger agreed to allow vehicle and charging data to be collected. In CA, The EV Project deployed chargers in San Diego, the San Francisco Bay Area, and Los Angeles.

Oregon

Sales of PEVs in OR were higher on a per capita basis than in any state other than CA and WA. A higher percentage of PEVs sold in OR as of June 2015 were BEVs than PHEVs: 60% BEVs to 40% PHEVs. This was counter to the national average of 47% BEVs to 53% PHEVs.

There were no State incentives directly for consumer to vehicle purchase and use but indirectly there were incentives for charging and several efforts at promotion. The Residential Energy Tax Credits program allowed qualified residents to receive a 25 percent tax credit for "alternative fuel infrastructure," including EV chargers of up to $750. The Alternative Fueling Infrastructure Tax Credit for Businesses allowed qualified businesses to receive a 35 percent tax credit of eligible costs for alternative fuel infrastructure. Per the U.S. Department of Energy's (DOE) Alternative Fuels Data Center (AFDC), there were 399 electric stations and 944 charging outlets in the state. OR was part of the West Coast Green Highway with California and WA.

The state released a PEV readiness plan, Energize Oregon, in 2013 with the goal to increase sales of PEVs in OR. It focused on four areas: 1) Outreach, Education, and Communications, 2) Policy and Inducements, 3) Deployment, and 4) Utilities. The Oregon Department of Transportation, the governor, and Drive Oregon established the Energize Oregon Coalition to implement the plan. Drive Oregon was a nonprofit trade association fostering growth in OR of businesses throughout the ZEV supply chain.

The Oregon Tourism Commission, vehicle manufacturers, universities, and public agencies collaborated on the Oregon Electric Byways initiative to promote PEV tourism. They provided market research and itineraries to guide the placement of electric vehicle supply equipment (EVSE), i.e., PEV charging infrastructure, throughout OR.

The State of Oregon Building Codes Division established a single permit for the installation of EVSE. OR was the first state in the U.S. to participate in the Workplace Charging Challenge, created by the U.S. Department of Energy, to increase the number of employers that provide charging at workplaces.

Washington

The state was an early ZEV market leader based on market share if not market size. As of the end of 2014, there were 12,351 PEVs registered in WA, up from 7,896 at the end of 2013. King County, home to the City of Seattle, had more than half of the state's PEVs.

Incentives provided by the state tended to be limited to BEVs. WA residents who purchased or leased a new BEV were exempt from state motor vehicle sales and use tax. The tax exemption did not apply to PHEVs. Alternative fuel (which includes electricity) and hybrid vehicles were exempt from vehicle emissions inspections. In lieu of sales and use taxes, WA imposed a BEV registration fee of $100 a year to contribute to repair roads and highways. The state was considering whether to move to such a use tax for all vehicles. The flat $100 annual fee for BEVs was expected to remain in place until the larger issue of how to tax motor vehicles was resolved. Sales tax exemption was also extended to the purchase of batteries for BEVs and labor and services rendered for installing, repairing, altering, or improving BEV batteries and components of BEV infrastructure and installation.

The electric utility Puget Sound Energy (PSE) offered a $500 rebate for the purchase and installation of Level 2 (220 -240V) electric vehicle supply equipment (EVSE) for PSE residential customers who were the registered owner of a BEV and installed their EVSE within a specific time frame. This program for the first 5,000 customers who apply was expected to last until November 1, 2016. PSE serves much of the Puget Sound area with either or both electricity and natural gas. Notably though, it is not the electricity service provider for the cities of Tacoma or Seattle (or more generally for any of the urban area between Puget Sound and Lake WA north of Seattle into Snohomish County).

As of June 2015, the AFDC reported there were 483 public PEV charging stations with 1,300 outlets. Most of the public PEV charging stations were in the greater Puget Sound region, along Interstate 5, and around the City of Vancouver, WA. WA's West Coast Electric Highway PEV chargers were free to users until April 2014 and then a $7.50 per use or $20 monthly subscription fee for unlimited use were instituted; charger use remained high.

Maryland

In 2010, there was one BEV registered in MD, in 2012 there were 657, and by 2013 there were over 1,700; over a third of these were registered in Montgomery County. Montgomery County borders Washington D.C., has a population of over 1 million people, and is one of the most affluent counties in the United States. As of June 2015, 29% of the ZEVs sold or leased in MD were BEVs and 71% were PHEVs.

Additional state incentives available to PEV buyers included:

1. HOV lane exemption for single occupant vehicles;
2. Plug-in Electric Vehicle Tax Credit equal to $125 times the number of kilowatt-hours capacity of the vehicle's battery up to a maximum of $3,000. Credit was authorized for the period 1 July 2014 to 1 July 2017; and
3. EVSE Tax Credit and Rebate offered by the Maryland Energy Administration: a state income tax credit of up to 20% of the cost of a qualified EVSE.
    a. Credit may not exceed $4,000 or the state income tax imposed for that tax year.
    b. Rebate program for the costs of acquiring and installing qualified EVSE, amounts vary but may not exceed 50% of the costs of acquiring and installing qualified EVSE. The program was approved for the period 1 July 2014 to 30 June 2016.

There are also several incentives available through local power utilities. Pepco provides electricity to Washington D.C. and the surrounding portions of Montgomery and Prince Georges Counties, MD. It offers a Plug-in Electric Vehicle Charging Pilot Program through which a PEV driver can select a whole house time of use electricity rate or a plug-in vehicle rate that applies only to a charging station; this requires a second meter which Pepco will provide with no cost to the customer. For customers who have not installed a Level 2 EVSE, Pepco will provide and install Level 2 EVSE for the first 50 qualified customers who sign up for the program and will cover 50% of the cost of the EVSE. These customers will get a second meter and PEV rate. Baltimore Gas and Electric Company offer a Plug-in Electric Vehicle Pilot Rate, a time of use rate for customers who purchase or lease a PEV.

The Maryland Electric Vehicle Infrastructure Council, established in 2011, evaluates PEV and EVSE incentives. They develop recommendations for a statewide infrastructure plan and the development of other potential policies to promote the successful integration of BEVs into communities and the transportation system.

Per the AFDC, MD had 270 electric stations with 614 chargers, but no hydrogen refueling.

Massachusetts

As of June 2015, 39% of the PEVs sold or leased in MA were BEVs and 61% were PHEVs, compared with the national average of 47% BEVs and 53% PHEVs.

Additional state incentives include:

1. Massachusetts Offers Rebates for Electric Vehicles (MOR-EV) offered rebates up to $2,500 for the purchase of a PEV;
2. The Clean Vehicle Project provided grants to private and public fleets to purchase PEVs and infrastructure to support them;

3. Electric Vehicle Emissions Inspection Exemption;
4. The Massachusetts Department of Environmental Protection had an open grant program to provide incentives to state agencies, towns, cities, colleges, universities and driving schools to acquire BEVs and charging stations; and,
5. The Massachusetts Department of Environmental Protection had an open grant program to incentivize employers to install Level 1 and Level 2 charging stations.

Massachusetts' Electric Vehicle Initiative aims to coordinate participation of over 90 stakeholders to accelerate the deployment of PEVs in the state. The Massachusetts Electric Vehicle Task Force began in September 2013 and focuses on incentives, infrastructure, and education.

Per the AFDC, there were 336 electric stations and 850 charging outlets in the state. Logan Airport near Boston had 26 chargers with free charging and 173 parking spaces for alternative fuels including hydrogen. Massachusetts' Department of Transportation was offering Electric Vehicle Plates, a unique license plate to alert emergency responders to use special safety techniques in the event of an accident.

New Jersey

As of June 2015, 38% of the PEVs sold or leased in NJ were BEVs and 62% were PHEVs, compared with the national average of 47% BEVs and 53% PHEVs sold or leased.

Additional incentives and activities in the NJ include:

1. Vehicle Toll Incentive offered by The New Jersey Turnpike Authority gave a 10 percent discount from off-peak toll rates on the New Jersey Turnpike and Garden State Parkway through NJ EZ-Pass; set to expire November 30, 2018;
2. Sales and Use Tax Exemption for Zero Emission Vehicles sold, leased, or rented in NJ, the exemption from the 7% tax was only for vehicles defined to be ZEVs;
3. After first enforcing state law prohibiting direct vehicle sales to consumers, NJ modified state law to allow motor vehicle franchisors who manufacture only ZEVs to directly sell to consumers;
4. Public Service Electric & Gas (PSE&G) Company provided "smart" charging equipment for 150 cars to companies in its service territory that have at least 5 employees who will use an PEV for their commute. PSG&E covered the cost of the charging equipment and the participating workplaces paid for installation and the cost of the electricity used.

Per the AFDC, there were 136 electric stations and 320 charging outlets in the state. In August 2015, the New Jersey Senate approved a bill requiring the New Jersey Transportation Authority to install four charging stations at rest areas on the Garden State Parkway, four along the New Jersey Turnpike, and two along the Atlantic City Expressway within the next three years. Similar legislation in the Assembly had not been voted on by the full house.

The state of NJ joined 10 other states and the District of Columbia to form the Transportation and Climate Initiative (TCI). TCI "seeks to develop the clean energy economy and reduce oil dependence and greenhouse gas emissions from the transportation sector." Among the transportation-related programs is the Northeast Electric Vehicle Network to facilitate deployment of PEV charging.

New York

As of June 2015, 25% of the PEVs sold or leased in NY were BEVs and 75% were PHEVs, compared with the national average of 47% BEVs and 53% PHEVs sold or leased.

Additional state programs, whether pilot or permanent at the time of this study, included:

1. Clean Pass Program allowed HOV lane exemption for HEVs, PHEVs, and BEVs on the Long Island Expressway. Although created in March 2006 as an expected one-year pilot program, it continued without an anticipated end date;
2. 10% discount on established E-ZPass accounts (E-ZPass offers reduced tolls and shorter wait times at tolling facilities);
3. Alternative Fuel Vehicle Recharging Tax Credit provided a tax credit of up to $5,000 for 50% of the cost to purchase and install alternative fuel vehicle refueling (including hydrogen) and EV recharging property. This was available to transportation and transmission corporations, cooperative agricultural corporations, and general business corporations. The tax credit was to be available through 31 December 2017;
4. Reduced tolls during off-peak hours at Port Authority crossings;
5. Emissions inspection exemption for vehicles that run exclusively on electricity;
6. State and Use Tax Exemption for Alternative Fuels which exempted hydrogen from state sales and use tax when used exclusively to power a motor vehicle; and
7. Plug-in Electric Vehicle rate reduction for residential ConEdison customers (applies to electricity used during the designated off-peak period).

Per the AFDC, there were 476 electric stations and 1,064 charging outlets in the state. NY exempts hydrogen from state sales and use taxes, but there are no locations selling hydrogen for fuel cell vehicles. Further, it appears that in NY state incentives for the installation of hydrogen refueling and the purchase of fuel cell vehicles expired 31 December 2014. NY has the fifth most PEV charging stations in the country and the most in the northeast. Charge NY, an initiative of the NY Power Authority and the NY State Energy Research and Development Authority, aims to create a statewide network of up to 3,000 public and workplace charging stations over the next five years.

As one local initiative, New York City Council passed a law in December 2013 requiring 20% of any parking spaces in new construction of open lots and garages be ready for PEV charging and older lots be upgraded to allow PEV charging. Retail parking is exempt.

Delaware

Per the Office of Energy Efficiency and Renewable Energy database, 31% of the ZEVs sold in DE in 2014 were BEVs and 69% were PHEVs. According to the AFDC, DE had 17 electric charging stations with 35 charging outlets.

DE adopted a Low Emission Vehicle (LEV) Program matching California's LEV program. Starting with model year 2014, only light- and medium-duty vehicles certified by the State of California according to Title 13 of California Codes and Regulations may be sold in the State of Delaware. This was also in effect in NY, CT, ME, MD, RI, Pennsylvania, VT, WA, OR, NJ, MA, New Mexico, and Arizona. It is relevant that all states surrounding DE (MD, NJ, and Pennsylvania) are in this list, limiting opportunities for residents of DE to purchase non-complying vehicles out-of-state. Beyond this, there was little other direct or indirect policy support for EVs.

Other NESCAUM Member States

The state of Connecticut created the Electric Vehicle Infrastructure Council to strategize how to support and promote PEVs. The Council made its final report to the Governor's office in Sept. 2010. In ME, the Greater Portland Council of Governments/ME Clean Communities EV Lending Program allowed municipalities and stakeholders to borrow a Nissan Leaf for up to several days. The program is credited with subsequent PEV leases by five municipalities and one stakeholder and the installation of 14 PEV charging stations. Starting as a pilot project in 2014, Drive Electric VT offered consumers a $500 point-of-purchase incentive for PEVs. Funding for the incentives came from the VT Low-Income Trust for Electricity. The program funded 75 incentives through participating automotive dealerships. As the pilot was complete, Drive Electric VT was pursuing funding to continue the incentives. At that point in time, there were no additional incentives (beyond the federal tax credit) for consumer PEV purchases in VT. Through the State Infrastructure Bank, the VT Economic Development Authority, along with the VT Agency of Transportation and the Federal Highway Administration, provided a 1% fixed interest rate on a loan up to $100,000 for sole proprietorships, partnerships, corporations, and municipalities to purchase or install PEV charging stations intended for use by the general public.

Methods

Data

Data were collected from new car-buyers in the study states at the end of 2014 [1]. Descriptions of the research design including sampling, questionnaire development, sample sizes, and other details are available in the previous state and region reports; the most expansive description including an annotated version of the on-line questionnaire is in the original CA report [7]. Briefly, the study collected data via an on-line questionnaire administered to households who purchase new cars in thirteen U.S. states and interviews with a small set of survey respondents in CA, OR, and WA. State-level analyses were conducted using survey data in eight of these states; the other five states—CT, ME, NH, RI, and VT—were included in the NESCAUM regional report with the other NESCAUM member states—MA, NJ, and NY for which there were state-level reports, too. The questionnaire gathered information on:

- Household travel context including vehicle purchases, fuel expenditures, and characteristics of daily travel;
- Awareness, knowledge, experience, and consideration of electric drive vehicles;
- Prospective designs of a next new household vehicle ascertained through vehicle design games that presented the performance and price of PHEV, BEV, and FCEV options compared to conventional vehicles, ICEVs and HEVs;
- Motivations for or against designing a PHEV, BEV, or FCEV as a next new vehicle;
- Environmental beliefs specific to air quality and climate change; and,
- Personal and household socio-economic and demographic descriptions.

The follow-up interviews in CA, OR, and WA were conducted in early 2015 with a small number of the survey participants. Interview participants were selected from across the spectrum of vehicle designs to gather additional insights from different people interested in a wide variety of vehicle drivetrain types and body styles.

Measuring Prospective Interest in ZEVs

Prospective interest in ZEVs is the interest participants show looking forward to future vehicle purchases. This interest is assessed via a series of vehicle design games in the on-line survey. One goal of the games is to ground each participant's gameplay in as many personalized details as possible. For example, each participant selects a starting vehicle make and model. The possibilities to design that vehicle with a conventional, hybrid, plug-in hybrid, battery electric, and fuel-cell drivetrain are then presented. Within all of the ZEV drivetrains, (electric) driving range, charging durations, and prices are all inter-related options. The underlying price model was realistic for late-2014; it did not look forward to lower future prices. However, because of uncertainty in prices, participants play the game multiple times (up to three) with different prices. The lowest prices were presented in the context of incentives modeled after the then current federal tax credit and California's Clean Vehicle Rebate (CVR). That is, all participants were shown both ZEV prices and the reductions due to incentives that varied as they would according to the then current federal tax credit and California CVR. The vehicle designs from this final version of the game are the dependent variable: prospective interest in ZEVs.

Sample Sizes

Sample size targets were fixed for states with state-level analyses: CA (n = 1,700), NY (n = 1,000), OR, WA, MA, and NJ, (n = 500), MD (n = 400), and DE (n = 200). The sample sizes of other NESCAUM-member states were in the same proportion to the NY sample size as their state population was to NY's. The model sample sizes, i.e., after all data cleaning and recoding, for all states as well as the NESCAUM region are shown in Table 1. State and NESCAUM Sample Sizes. The widely varying sample sizes affect the state-level analyses conducted here. For example, for a given statistical model, smaller sample sizes will generally produce fewer statistically significant parameter estimates; the same effect size may be statistically significant in a larger sample if that larger sample reduces the standard errors of the estimates. For this reason, quantitative comparisons of statistical models are made within each state or region. Once the best model for each state or region is selected, comparisons and contrasts across states are made conceptually, that is, do the different state and regional models tell us something similar or different about the role of gender in prospective interest?

Table 1. State and NESCAUM Sample Sizes

State/Region	Sample size for state-level analyses
California	1,659
Oregon	361
Washington	453
Delaware	200
Maryland	293
NESCAUM Member States	
State-level analysis conducted	
Massachusetts	493
New Jersey	490
New York	987
No State-level analysis	
Connecticut	178
Maine	68
New Hampshire	68
Rhode Island	54
Vermont	32
NESCAUM sub-total	2,370
All States Total	5,336

Variables associated with Gender Hypotheses

Hypotheses related to gender differences in responses to ZEVs were developed based on analysis of transcripts from the post-survey interviews conducted in CA, OR, and WA. The interviews were coded for themes, then participants' statements associated with each theme were coded by whether the speaker was female or male. The relative preponderance of female and male speakers associated with these statements, the positive or negative valence of statements on a theme, a different sub-theme within a theme, e.g., concern with air quality vs. batteries in landfills within an environmental theme, all suggested hypotheses to be tested in the survey samples.

The data for CA were re-analyzed to test these hypotheses in the context of the early EV market [1]. The analyses presented here test those same hypotheses in the generally less developed and less supportive contexts of the other ZEV states and the NESCAUM region. As was done for CA, the original state and region models on prospective interest in ZEVs are amended with interaction terms between the survey taker's sex identifier and variables measuring or related to the gender hypotheses. For example, variables for sex identifier and personal interest in ZEV technology test whether prospective interest in ZEVs is different between females and males and differs by interest in the technology, per se. Adding an interaction term between the sex identifier and interest in ZEV technology allows a test of whether the effects of interest in ZEV technology are different for female and male participants. This is a complete list of variables for which an interaction with a variable for a binary sex identifier is added to state and regional models as described in the next section:

- Electricity is a likely replacement for gasoline and diesel
- Home PEV charging access
- Familiarity factor: HEV, BEV, PHEV, FCEV
- Familiarity factor: ICEV
- Driving experience factor: HEV
- Prior PEV evaluation factor: safety, reliability
- Prior PEV evaluation factor: range, fueling/charging duration
- Prior consideration of PEVs
- Participant's own interest in ZEV technology
- Environmental concerns factor: personal worry about air quality, air pollution is a regional health threat

Base and Alternative Logistic Regression Models

For each state and the NESCAUM region, a base model was estimated of the probability a participant created and selected a vehicle of a general drivetrain type: ICEV, HEV, PHEV, BEV, or FCEV. As these are distinct types, modeling is done via nominal logistic regression. The base models presented in each of the original state and region reports [7-15] were selected to be the most parsimonious model for that state or region that provided an acceptable fit to the data. They were not selected to provide a consistent test of identical models across states and the NESCAUM region nor to explicitly test any hypotheses regarding gender.

As the goal of the present analysis is to assess the same hypotheses regarding the potential effects of gender across policy and market contexts, the first step is to re-estimate a new "base" model for each state and region starting with a similar set of explanatory variables. The second step is to add to each new base model interactions (as crossed effects) between participants' binary sex identifier and select explanatory variables. For the first step, each state or region model includes variables that belong to one of four sets. Each set was added in sequence. Once a subsequent set is added, variables are step-wise eliminated starting with the one that contributes the least to the model's ability to explain drivetrain type. Once all variables that do not make a statistically significant contribution are eliminated, the next set of variables is added and the process repeats. These are the variables within each of the four sets (variable names highlighted in **bold**):

1. Socio-economic and demographic descriptors of participants and their households;
    a. **Participant education**;
    b. **Participant sex**; and,

    c. **Household income**
2. Context variables describing vehicle purchases and holdings, daily travel, residences, and home parking;
    a. **Price paid for most recently acquired new vehicle**;
    b. **Participant's vehicle's fuel economy (miles per gallon)**;
    c. **Participant's vehicle's monthly miles (miles per month)**;
    d. **Participant's vehicle fuel spending per month (dollars per month)**;
    e. **Flexibility as to who drives which vehicle (four-point scale)**;
        i. Scale allows that a participant may be the only driver in a household
    f. **Participant commutes to a workplace (y/n)**;
    g. **Park at least one vehicle in a garage or carport at home (y/n)**;
    h. **Home PEV charging access (No or don't know/110volt/220volt/EVSE)**;
    i. **Electricity installation authority at residence (y/n)**; and,
    j. **Access to natural gas at residence (y/n)**,
3. Attitudes related to air quality and public policy making;
    a. **Should government offer incentives (yes, for both electricity and hydrogen; yes but electricity only, yes but hydrogen only, don't know;** or **no, neither)**; and,
    b. **Environmental Beliefs**
        i. comparison of the relative health risk posed by electricity and gasoline,
        comparison of the environmental risk posed by electricity vs. gasoline,
        personal worry about air quality,
        belief air pollution is a regional health threat,
        belief air pollution can be reduced via individual lifestyle change
        certainty about evidence for (or against) global warming,
        belief climate change can be reduced via individual lifestyle changes; and,
4. Awareness, knowledge, assessments, and consideration of ZEVs;
    a. **Electricity is a likely replacement for gasoline and diesel (y/n)**;
    b. **Hydrogen is a likely replacement for gasoline and diesel (y/n)**;
    c. **Seen public charges for PEV**;
    d. **Familiarity with drivetrain types (ICEVs, HEVs, PHEVs, BEVs, and FCEVs)**;
    e. **Driving experience with drivetrain types (ICEVs, HEVs, PHEVs, BEVs, and FCEVs**;
    f. **Prior (i.e., prior to completing their vehicle design) evaluation of PEVs**;
        i. range, fueling/charging duration, purchase price, safety, reliability, presence of home charger, and presence of public chargers
    g. **Prior (i.e., prior to completing their vehicle design) evaluation of FCEVs**;
        i. range, fueling/charging duration, purchase price, safety, reliability, and presence of public fueling
    h. **Participant's own interest in ZEV technology**;

i. **Prior consideration of PEVs**;

j. **Prior consideration of FCEVs**;

k. **Awareness for incentives from the federal or state government to buy and drive alternative fuel vehicles**; and,

l. **Body size of the new next vehicle (compact, midsize, large)**

The variables **Participant's vehicle's fuel economy**, **Participant's vehicle's monthly miles**, and **Participant's vehicle fuel spending per month** were truncated at their upper ends to exclude extreme outliers.

Five sets of the survey questions are assumed to be related to latent, or underlying, constructs:

3b. Environmental concerns;
4d. Familiarity with different powertrains;
4e. Driving experience with different powertrains;
4f. Prior PEV evaluations (in terms of range, fueling/charging duration, purchase price, safety, reliability, presence of home charger, and presence of public chargers); and,
4g. Prior FCEV evaluations (in terms of range, fueling/charging duration, purchase price, safety, reliability, and presence of public fueling).

Factor analysis was conducted on the variables related to each latent construct to determine whether a smaller number of factors adequately account for the variation in the variables. If so, then those factors are used in the logistic regression modeling. To increase consistency in these factors across the state and NESCAUM models, factors were re-estimated allowing the use of one of two factor rotation methods. If an orthogonal rotation (i.e., Varimax) returns acceptable f factor loadings, those loadings are used. The criteria for "acceptable" include a loading absolute value of 0.3 or higher on at one and only one factor. However, for some constructs in some states a non-orthogonal rotation (i.e., Promax) improved factor loadings (from marginally acceptable to the range of acceptable to excellent), variance accounted for by the factors, or both to such an extent the non-orthogonal factors are used. Table 2 presents the rotation method for each latent construct that in the base models.

Table 2. Rotation method of latent constructs for state and region models[1,2]

	CA	MA	NESCAUM	NJ	OR	WA
Familiarity with drivetrains	Varimax	NA	Varimax	Promax	NA	Promax
Experience with drivetrains	Varimax	NA	Promax	Promax	NA	Promax
Prior PEV evaluations	Varimax	Promax	Promax	Promax	Promax	Varimax
Prior FCEV evaluations	Varimax	NA	Promax	NA	NA	NA
Environmental concerns	Varimax	Varimax	Varimax	NA	Varimax	Promax

1. NA: not applicable as factors for this construct don't appear as an explanatory variable in the logistic model.
2. The states DE, MD, and NY are not presented since no factor from any construct appears their model.s

Measures of overall model performance are compared in this sequence: a) The newly estimated base model is b) compared to that base model plus a binary indicator variable for participant sex (female/male) if that variable is not already in the new base model, and then c) compared to the base model plus participant sex, plus participant sex interacted with variables related to specific hypotheses about potential systematic differences in the drivetrain types selected by female and male participants.

In going from a) to b) to c), overall model performance is measured by three metrics: R^2, AIC_c, and BIC. R^2 is an indication of the variation in drivetrain design accounted for the model; it always increases with the addition of independent variables. AIC_c and BIC assess whether the increase in R^2 is large compared to the additional complexity (measured by the increase in the degrees of freedom (DF)). Smaller AIC_c and BIC (as independent variables are added) indicate a better performing model.

In going from a) to b), the presence of the indicator variable for participant sex explicitly tests whether there is a difference between female and male respondents in their likeliness to design a vehicle of any particular drivetrain type controlling for all other variables in the model. For the purposes of this report, an explicit test of the sex identifier is preferred to simply omitting a non-significant sex identifier (in the name of parsimony as may have been done with the original state and region models). In going from models b) to c), the interactions between participant sex and other variables test the hypotheses that the effect of the other variables (which are crossed with participant sex) differ for female and male participants and that the additional variables improve the model enough to make a statistically significant increase in its overall performance. If the crossed effects are significant (as indicated by parameter tests) and the model performance is improved (as discussed above), these support a conclusion for a sex-based difference in the probabilities of designing different drivetrain types. From such results, inferences may be drawn about gender-based differences in responses to PEVs.

Pro- and Con-ZEV Motivations: One-Way ANOVAs

After participants design their next new vehicle, they are asked to score motivations for or against designing a ZEV, depending on whether they did or did not select one in the final vehicle design game. The motivation statements were derived from prior research [1, 7-15] and are scored on a scale of 0 (completely unimportant) to 5 (very important). There are 16 possible motivations for designing a ZEV and 18 for not. Participants are given only 30 points to spend across all motivations for or against selecting a ZEV; they do not have to spend them all.

Overall, female and male participants assigned different numbers of points for or against designing a ZEV. To account for this difference, the motivation scores of female participants were modified by an amount equal to the ratio of the male mean total scores to the female mean total scores within the ZEV designers and non-ZEV designers, respectively. Then, for each state, one-way ANOVAs were conducted, to compare means of female and male participants.

Results

Prospective Interest in ZEVs

The distributions of the participants' drivetrain designs are compared across jurisdictions, i.e., states and region for which there is a separate analysis, and **Participant sex** in Figure 3. Everywhere and regardless of sex, more participants design ICEVs or HEVs than ZEVs. In western states (CA, OR, and WA), higher percentages of both female and male participants designed a PHEV, BEV or FCEV than in eastern states. This corresponds to the policy and market contexts. CA, OR, and WA all had cities in which sales of the Nissan Leaf BEV launched at the end of 2010. OR had adopted CA's ZEV regulations and was a member of the multi-state ZEV Program Implementation Task Force. WA had done neither of these. The three states each made commitments to a West Coast Electric Highway, an effort to place PEV charging at frequent intervals along U.S. Interstate 5 through WA, OR, and CA. These three states were in the top 5 by rate of registrations of Tesla's Model S circa late-2013; no other state in this study was in the top-10. The eastern states are mixed as to whether they'd adopted CA's ZEV regulations (most had). The nearest Nissan Leaf launch city was Washington, DC, which may have provided some EV marketing halo for MD but seems unlikely to have had such an effect throughout the more distant NESCAUM member states.

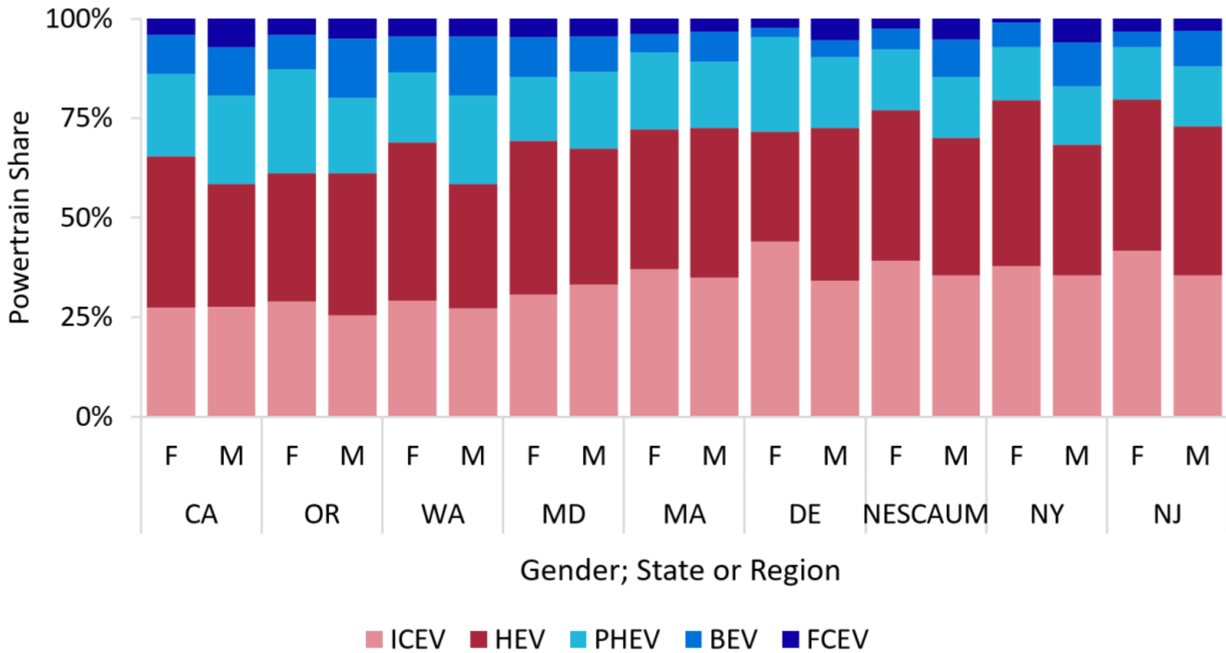

Figure 3. Drivetrain types from all games by gender and state or region, ordered left to right from high to low of the total percent of total ZEVs designed by females (CA on the left for comparison).

Across jurisdictions, 20 to 39 percent of female participants designed a ZEV as their next new household vehicle; 27 to 42 percent of male participants did so. As these overlapping ranges hint, there are neither pervasive nor large differences between female and male respondents within jurisdictions nor do they show a clear pattern across jurisdictions, i.e., ZEV market and policy contexts. There is no difference between female and male selections of drivetrain types that approaches the skew of the actual EV market toward males. Tests of homogeneity of proportions indicate the differences between female and male participants in CA, NY, and across the NESCAUM region are large enough to be statistically significant ($p \leq 0.05$).

Neither is there a pattern of differences in prospective interest between female and male respondents corresponding to levels of market and policy development: there are differences between states with higher and lower market and policy context just as there are states with higher and lower policy and market contexts with no differences. As described in the policy review, CA had the largest ZEV market and the highest level of policy support. In contrast, in late-2014 NY had some local road and bridge toll incentives, reduced electricity rates for PEV charging, and incentives for PEV charging and hydrogen fueling (for FCEVs) but no state ZEV purchase incentive for consumers. Respondents in CA showed a higher overall interest in ZEVs, but the two states showed similar gender differences. In all other states in this analysis—OR, WA, DE, MD, MA, and NJ (the last two, also NESCAUM members)—there is no evidence of statistically significant difference in prospective interest in ZEVs based on participant sex. OR and WA had larger ZEV market shares, but MD and MA had more supportive policies, including state incentives for vehicle purchases offered by neither OR nor WA.

The multivariate modelling examines whether in each jurisdiction any of these apparent differences is due to **Participant Sex** or its interaction with other variables. For most jurisdictions, no alternative model containing the variable **Participant sex** or any crossed effect between **Participant sex** and other explanatory variables improves the base model which excludes **Participant sex**. No hypothesis about an overall effect of **Participant Sex** on drivetrain type nor about different effects of select explanatory variables for female and male participants is supported. This does not contradict the results shown in Figure 3; it means that whatever apparent differences between the proportions of female and male participants in their selection of drivetrains may be, they are not due to this binary sex distinction, per se. (See the Appendix for the base and alternative models for every state and the NESCAUM region.)

The two exceptions to this conclusion are NY and the NESCAUM region. See Table 3 for the NY model test and Table 4 for the NY alternative model. See Table 5 for the NESCAUM model test and Table 6 for the NESCAUM alternative model. First, the variable for **Participant sex** is statistically significant in both base models. Both base models estimate female participants are *more* likely than male participants to design their next new vehicle to be any type of a ZEV though most of the difference is for BEVs and PHEVs.[3] Since NY is such a large part of the NESCAUM region (by area and population) and since **Participant sex** is not statistically significant in the MA or NJ base models, it is possible the appearance of **Participant sex** in the NESCAUM base model is due solely to NY. To check this, a model for NESCAUM minus NY was

[3] So few participants anywhere select FCEVs that for practical purposes results for ZEVs tend to reduce to results for PEVs.

estimated: **Participant sex** is still statistically significant, suggesting the sex-based difference exists more broadly across NESCAUM states—though not in MA and NJ.

Table 3. NY Model Tests: base model and base plus selected cross-effects of sex

	R^2	AIC_C	BIC	DF
Base model	0.145	1916.2	2098.8	36
Base + Participant sex crossed by the following, one at a time:				
Participant’s own interest in ZEV technology	0.146	1922.5	2122.8	40
Participant’s vehicle’s monthly miles	**0.153**	***1908.5***	**2108.8**	**40**
Seen public charges for PEV	0.147	1919.6	2119.9	40
Prior consideration of PEVs	0.152	1919	2137	44
Prior consideration of FCEVs	0.151	1920.5	2138.5	44
Personal worry about air quality	0.147	1920.7	2121	40

Table 4. NY Model of Respondent Drivetrain design, base model and respondent sex crossed with Participant’s vehicle’s monthly miles

Whole Model Test				
Model	**-LogLikelihood**	**DF**	**Chi-Square**	**Prob. > ChiSq**
Difference	163.2505	40	326.5009	<.0001
Full	907.576			
Reduced	1070.8264			

Lack of Fit			
Source	**DF**	**-LogLikelihood**	**Chi-Square**
Lack of Fit	3052	898.73495	1797.47
Saturated	3092	8.84101	**Prob. > ChiSq**
Fitted	40	907.57596	1.000

Effect Likelihood Ratio Tests			
Source	**DF**	**Likelihood Ratio Chi-Square**	**Prob. > ChiSq**
Participant sex	4	16.5724	0.0023
Participant’s own interest in ZEV technology	4	47.1237	<.0001
Participant’s vehicle’s monthly miles	4	17.1399	0.0018
Seen public charges for PEV	4	20.1230	0.0005
Prior consideration of PEVs	8	39.9669	<.0001
Prior consideration of FCEVs	8	18.4897	0.0178
Personal worry about air quality	4	23.5560	<.0001
Participant sex * Participant’s vehicle’s monthly miles	**4**	**16.6890**	***0.0022***

Table 5. NESCAUM Model Tests: base model and base and selected effects crossed with sex

	R^2	AIC_C	BIC	DF
Base model	0.1787	5553.58	6431.67	152
Base + Participant sex crossed by the following, one at a time:				
Participant education	0.1813	5574	6539.46	168
Participant's own interest in ZEV technology	0.18	5572.84	6516.51	164
Environmental concerns factor: personal worry about air quality, air pollution is a regional health threat, air pollution can be reduced if individuals make changes in their lifestyle, climate change, global warming, urgent national need	0.179	5560.67	6460.65	156
Environmental concerns factor: comparison of the possessed environmental risk by BEV and ICEV, comparison of the possessed health risk by BEV and ICEV	0.1791	5560.14	6460.13	156
Prior PEV evaluation factor: range, fueling/charging duration, purchase price	0.1792	5559.16	6459.14	156
Prior PEV evaluation factor: safety, reliability	**0.1805**	***5550.94***	**6450.92**	**156**
Prior PEV evaluation factor: presence of home charger, presence of public chargers	0.1792	5559.45	6459.43	156
Driving experience factor: HEV	0.1797	5555.99	6455.97	156
Familiarity factor: ICEV	0.1795	5557.34	6457.32	156
Prior consideration of PEVs	0.1825	5566.31	6531.78	168
Prior consideration of FCEVs	0.1818	5561.38	6505.05	164
Should government offer incentives	0.1817	5571.21	6536.68	168
Park at least one vehicle in a garage or carport at home	0.1787	5562.37	6462.35	156
Participant commutes to a workplace	0.1794	5558.49	6458.47	156
Electricity is a likely replacement for gasoline and diesel	0.179	5560.72	6460.7	156
Hydrogen is a likely replacement for gasoline and diesel	0.179	5560.47	6460.45	156
Seen public charges for PEV	0.1808	5576.87	6542.33	168
Household income	0.1788	5561.92	6461.9	156
Prior FCEV evaluation factor: range, fueling/charging duration, (minus of) presence of public chargers	0.1793	5558.92	6458.9	156
Prior FCEV evaluation factor: safety, reliability	0.1793	5559.03	6459.01	156
Prior FCEV evaluation factor: purchase price	0.1791	5560.09	6460.07	156

Table 6. NESCAUM Model of Respondent Drivetrain design, base model and respondent sex crossed with Prior PEV experience factor2: safety, reliability

Whole Model Test

Model	**-LogLikelihood**	**DF**	**Chi-Square**	**Prob. > ChiSq**
Difference	573.6675	156	1147.335	<.0001
Full	2603.8061			
Reduced	3177.4737			

Lack of Fit

Source	**DF**	**-LogLikelihood**	**Chi-Square**
Lack of Fit	9308	2603.8061	5207.612
Saturated	9464	0	**Prob. > ChiSq**
Fitted	156	2603.8061	1.0000

Effect Likelihood Ratio Tests

Source	**DF**	**Likelihood Ratio Chi-Square**	**Prob. > ChiSq**
Participant education	16	24.1750	0.0858
Participant’s own interest in ZEV technology	12	57.8360	<.0001
Participant sex	4	17.3467	0.0017
Environmental concerns factor: air quality: personal worry, regional health threat, subject to lifestyle change; climate change evidence, level of concern	4	26.9245	<.0001
Environmental concerns factor: comparison of the environmental and health risk posed by BEV and ICEV	4	10.6681	0.0306
Prior PEV evaluation factor: range, fueling/charging duration, purchase price	4	3.1191	0.5381
Prior PEV evaluation factor: safety, reliability	4	13.0164	0.0112
Prior PEV evaluation factor: home charging, presence of public chargers	4	7.9304	0.0942
Driving experience factor: HEV	4	24.3590	<.0001
Familiarity factor: ICEV	4	26.2097	<.0001
Prior consideration of PEVs	16	65.2433	<.0001
Prior consideration of FCEVs	12	31.2587	0.0018
Should government offer incentives	16	22.7462	0.1207
Park at least one vehicle in a garage or carport	4	11.2592	0.0238
Participant commutes to a workplace	4	8.9443	0.0625
Electricity a likely replacement for gas/diesel	4	5.2510	0.2625

Table continues on next page

Effect Likelihood Ratio Tests (continued) **Source**	**DF**	**Likelihood Ratio Chi-Square**	**Prob. > ChiSq**
Hydrogen a likely replacement for gasoline and diesel	4	24.5774	<.0001
Seen public PE chargers	16	40.1105	0.0008
Household income	4	4.6495	0.3252
Prior FCEV evaluation factor: range, fueling/charging duration, (minus of) presence of public charging	4	3.5775	0.4662
Prior FCEV evaluation factor: safety, reliability	4	1.4882	0.8287
Prior FCEV evaluation factor: purchase price	4	1.4233	0.8401
Participant sex * Prior PEV evaluation factor: safety, reliability	**4**	**11.8373**	***0.0186***

For both NY and NESCAUM, one additional interaction effect between **Participant sex** and another independent variable is found to both be statistically significant and to improve the overall performance of the model. For NY, adding a crossed effect between **Participant sex** and **Participant's vehicle's monthly miles** resulted in a model with an improved R^2 value (higher) and AIC_C and BIC (lower) compared with the base model. For NESCAUM, the addition of a crossed effect between **Participant sex** and the factor scores for the participants' evaluations of the safety and reliability of BEVs and PHEVs compared to conventional gasoline vehicles offered prior to completing their vehicle designs (**Prior PEV evaluation factor: safety, reliability**). For both these models, the crossed effects improve overall model performance and is statistically significant ($p \le 0.05$).

In NY, the main effect of **Participant's vehicle's monthly miles** is to increase the probability a participant designs a ZEV as monthly miles increase. The crossed effect between **Participant sex** and **Participant's vehicle's monthly miles** is such that it reveals opposite total effects (main effect plus crossed effect) for female and male participants. For female participants, the interaction strengthens the main effect causing the probability a female participant designs a ZEV to increase with the number of miles driven per month in the vehicle she drives most often. In contrast, for male participants the total effect is a slight but distinct reversal of the main effect, i.e., for male participants increasing number of miles driven per month in the vehicle they most often drive *decreases* the probability they design a ZEV and increases the probability they design a conventional gasoline vehicle.

For NESCAUM, the main effect of **Prior PEV evaluation factor: safety, reliability** is such that higher factor scores, i.e., stronger agreement that conventional vehicles are safer and more reliable than PEVs, are associated with higher probabilities of designing a conventional gasoline-powered vehicle. The interaction of **Participant sex** and **Prior PEV evaluation factor: safety, reliability** is such that these safety and reliability assessments have a stronger effect for female than male participants though the total effects are in the same direction for female and male participants: everyone is more inclined to select a conventional gasoline vehicle if they believe they are safer and more reliable than PEVs, but women even more so than men.

Motivations for and Against ZEVs

The average scores for each sex, state, and motivation statement are presented in Table 7for participants who designed a ZEV and Table 8 for those who designed an ICEV or HEV. The heatmaps show ranking scores by **Participant sex** within states and region where darker color indicates higher mean scores. The mean motivation scores from CA are included here for comparison much as the prior modeling in CA of vehicle drivetrain types is the basis for the prior section.

Across all participants who designed a ZEV everywhere in the seven states and across the NESCAUM region, fuel cost saving was on average the highest scored motivation. It is followed, in declining order, by interest in ZEV technology and a desire to reduce the impact of the participant's own driving on climate change and air quality. These four motivations have mean scores unambiguously higher than all other motivations. That is to say, for any differences by participant sex or jurisdiction discussed next these are the four most broadly compelling motivations to design and select a ZEV among those who did so.

Among participants who did not design a ZEV as their new next vehicle, the two motivations against doing so with the highest mean scores across all participants everywhere were limited charge/fuel networks and vehicle purchase cost. These are followed by unfamiliarity with ZEV technology, effect of PEVs on electricity supply, and driving range. Again, while differences will be discussed next, these five motivations against designing a ZEV appear to be most broadly inhibiting.

Differences in Motivations by Sex and State/Region

For each motivation, depending on whether there is a prior hypothesis about whether women are expected to be more motivated than men or vice versa the appropriate one-tail ANOVA is performed on the mean scores for female vs. male participants. Taking "female" as the first value, if the left-tailed t-test is significant ($p \leq 0.05$), then the mean score for female participants is statistically significantly higher than for male participants. Conversely, a right-tailed t-test tests whether the mean score for male participants is greater than that for female participants. The results of the appropriate one-tailed t-test for each motivation for designing the next new vehicle for the household as a ZEV is presented in Table 9 for participants who design a ZEV. The corresponding results for motivations against designing a ZEV are in Table 10 for participants who did not design a ZEV. In both figures, darker shading indicates a higher significance (lower p-value); empty cells indicate non-significant results, i.e., p-values higher than 0.05. Orange shading indicates higher mean scores for female participants; green, higher means scores for male participants.

Table 7. Mean Pro-ZEV Scores, Female and Male Respondents by State and Region, ranked from high to low global mean score

	CA		DE		MA		MD		NESCAUM		NJ		NY		OR		WA		Global Mean
	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	
Fuel cost	3.0	3.0	3.0	2.5	3.2	3.0	3.2	2.5	3.1	2.8	3.4	3.0	2.8	2.7	3.7	3.1	3.3	3.0	3.0
ZEV technology	2.3	2.6	2.3	2.6	2.6	2.5	2.3	2.8	2.2	2.7	2.1	3.0	2.2	2.8	2.0	2.7	2.5	2.5	2.5
Climate change	2.1	1.7	2.0	1.4	2.1	1.8	2.3	1.7	1.9	1.7	2.2	1.9	1.8	1.4	2.4	1.8	2.1	1.9	1.9
Air quality	2.2	1.6	1.5	1.7	2.3	1.7	1.9	1.5	1.9	1.7	2.3	1.9	1.6	1.6	2.3	1.9	2.2	1.9	1.9
Oil imports to US	1.7	1.4	1.4	1.9	1.9	1.6	1.3	1.2	1.7	1.5	1.8	1.3	1.5	1.5	1.9	1.7	1.7	1.5	1.6
Withhold money from oil producers	1.6	1.4	1.2	1.6	2.0	1.7	1.4	1.3	1.7	1.4	2.3	1.7	1.4	1.2	1.8	1.7	1.6	1.5	1.6
Fun to drive	1.4	1.7	1.3	1.8	1.3	1.6	1.5	1.6	1.4	1.7	1.4	2.1	1.5	1.6	1.2	1.6	1.7	1.7	1.5
Safety compared to ICEVs	1.4	1.7	1.6	1.6	1.5	1.7	1.4	1.7	1.6	1.5	1.8	1.5	1.7	1.5	1.1	1.4	1.3	1.0	1.5
Home charge convenience	1.3	1.4	1.7	1.6	1.4	1.2	1.5	1.8	1.3	1.4	1.6	1.7	1.1	1.4	1.5	1.6	1.3	1.7	1.5
Maintenance cost	1.0	1.2	1.2	1.2	1.3	1.3	1.1	1.0	1.2	1.2	1.1	1.2	1.2	1.2	1.1	1.1	1.1	1.3	1.2
Vehicle appearance	1.1	1.3	0.9	1.0	1.1	1.3	0.9	0.8	1.1	1.2	1.0	1.5	1.3	1.1	1.0	1.0	1.0	1.2	1.1
Lifestyle fit	1.2	1.2	1.0	0.9	1.0	1.1	1.1	1.0	1.1	1.1	0.7	1.1	1.3	1.2	1.0	1.3	1.1	1.6	1.1
Purchase cost	0.9	0.9	1.4	1.1	1.0	1.3	1.2	1.5	1.1	1.1	1.1	0.9	1.2	1.1	0.8	0.9	1.1	0.8	1.1
Comfortable	1.0	1.1	0.9	1.0	0.8	1.4	0.8	1.0	1.0	1.1	0.9	0.9	1.2	1.2	0.5	1.0	0.7	0.9	1.0
Incentives	1.0	1.0	1.3	1.0	1.0	1.1	0.9	1.1	0.9	1.0	0.9	1.1	0.7	1.1	0.8	0.6	0.7	1.1	1.0
Impression on peers	0.7	0.8	0.9	0.6	0.8	1.0	0.6	0.9	0.8	0.9	0.8	0.9	0.7	1.0	0.8	0.7	0.8	0.6	0.8

Table 8. Mean Non-ZEV Scores, Female and Male Respondents by State and Region, ranked from high to low global mean score

	CA		DE		MA		MD		NESCAUM		NJ		NY		OR		WA		Global Mean
	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	
Limited charging network	2.7	2.6	3.2	2.9	3.2	2.9	2.5	2.6	2.8	2.8	2.9	2.8	2.8	2.9	2.5	2.7	2.5	2.5	2.8
Purchase cost	2.2	2.3	1.9	2.8	2.1	2.3	2.3	2.4	2.1	2.1	2.1	2.2	2.3	2.1	2.4	2.5	1.9	2.1	2.2
Unfamiliar technology	2.1	1.6	2.4	2.1	2.4	2.1	2.1	1.6	2.3	1.9	2.4	1.9	2.3	2.1	1.9	1.7	1.9	1.8	2.0
Electricity supply	1.7	1.4	2.0	2.0	2.0	2.0	1.9	1.7	2.0	1.8	1.9	1.9	2.2	2.0	1.7	1.4	1.7	1.1	1.8
Range	1.7	2.2	1.4	1.9	1.6	1.9	1.4	2.1	1.7	1.8	1.8	1.7	1.7	1.8	1.8	1.8	1.6	2.1	1.8
Charging duration	1.4	1.5	1.5	1.1	1.4	1.6	1.4	1.3	1.5	1.6	1.5	1.5	1.7	1.7	1.1	1.4	1.3	1.7	1.5
No home charging	1.7	1.4	1.6	1.6	1.6	1.6	1.6	1.7	1.6	1.4	1.7	1.3	1.6	1.6	1.2	1.0	1.2	0.7	1.4
Maintenance cost	1.3	1.3	1.5	1.4	1.5	1.2	1.5	0.9	1.3	1.2	1.1	1.3	1.3	1.1	1.5	1.1	1.4	1.3	1.3
Technology unreliable	0.9	1.1	0.8	1.2	0.8	1.3	0.7	0.9	0.9	1.1	0.9	0.9	1.1	1.1	1.0	1.4	0.9	1.2	1.0
Battery concerns	1.0	1.2	0.8	1.2	0.9	1.1	1.0	1.2	0.9	1.0	0.9	1.0	0.9	0.9	1.1	1.1	1.0	1.0	1.0
Charging cost	1.2	0.9	1.3	0.7	1.0	0.8	1.0	0.9	1.0	1.0	0.8	1.1	1.2	1.0	1.1	1.1	1.1	0.4	1.0
Higher incentives	1.0	1.0	1.3	1.0	1.0	1.1	0.8	1.1	0.9	1.0	0.9	1.1	0.8	1.1	0.8	0.6	0.6	1.1	1.0
Vehicle safety	1.0	0.9	1.2	0.5	1.2	0.5	1.1	0.7	0.9	0.9	1.0	0.9	0.8	0.9	1.0	0.7	0.9	0.9	0.9
Lifestyle (mis)fit	0.6	0.7	0.5	0.9	0.7	0.8	0.4	0.7	0.7	0.8	0.7	0.7	0.6	0.7	0.7	0.8	0.7	0.6	0.7
Vehicle appearance	0.6	0.5	0.8	0.6	0.8	0.6	0.4	0.6	0.5	0.5	0.4	0.5	0.3	0.5	0.7	0.4	0.4	0.5	0.5
Charging safety	0.5	0.3	0.4	0.4	0.6	0.3	0.5	0.4	0.5	0.4	0.5	0.5	1.2	0.6	0.4	0.3	0.3	0.3	0.5
Environmental concerns	0.4	0.4	0.2	0.1	0.4	0.2	0.3	0.2	0.2	0.3	0.1	0.3	0.2	0.3	0.3	0.3	0.2	0.2	0.3
Impression on peers	0.3	0.3	0.3	0.3	0.2	0.3	0.2	0.2	0.2	0.3	0.2	0.4	0.2	0.2	0.3	0.2	0.2	0.1	0.2

There are statistically significant differences between female and male respondents' mean scores for almost every motivation in at least one jurisdiction. However, there are only two of the highly scored motivations for which differences by sex are common across multiple jurisdictions: interest in **ZEV technology** and the effects of the participants driving on the environment, especially **Climate change**. However, for any motivation for which there is a statistically significant difference in the mean scores between female and male participants in two or more jurisdictions, the difference is always in the same direction—if a difference between female and male respondents exists in more than one jurisdiction, women in all those places score the motivation more highly on average than men or vice versa. Of the motivations for designing a ZEV that were found to have statistically significantly different mean scores between female and male respondents in CA, no such difference is contradicted by results from other jurisdictions in this report—though differences found in CA may not be repeated here (for example, **Safety** and **Maintenance Cost**).

Table 9. Statistical Significance of Differences between Female (orange) and Male (green) Mean Pro-ZEV Motivations by State and Region

Motivation for Designing and Selecting a ZEV:	*p*-value of test for difference between mean score for female and male participants									Global Mean Score
	CA	DE	MA	MD	NES	NJ	NY	OR	WA	
Fuel cost				0.03	0.04			0.02		3.0
ZEV technology	0.04				0.00	0.01	0.02	0.00		2.5
Climate change	0.01			0.03			0.03	0.04		1.9
Air quality	0.00							0.05		1.9
Oil imports to US	0.02									1.6
Withhold money from oil producers					0.02					1.6
Fun to drive	0.02				0.01	0.02				1.5
Safety compared to ICEVs	0.02									1.5
Home charge convenience										1.5
Maintenance cost	0.04									1.2
Vehicle appearance										1.1
Lifestyle fit									0.03	1.1
Purchase cost										1.1
Comfortable			0.03					0.02		1.0
Incentives							0.04		0.04	1.0
Impression on peers							0.05			0.8

Fuel cost savings, which was the most highly scored motivation *across* all states and the NESCAUM region, was scored higher on average by female participants than male participants *within* each state and the NESAUM region. However, those differences are large enough to be statistically significant in only OR, MD, and the NESCAUM region (though not in any of the three state-level analyses for NESCAUM-member states: MA, NJ, and NY). Differences in mean motivation scores by **Participant Sex** are most pervasive for interest in **ZEV technology**. On average male participants score interest in **ZEV technology** more highly than female participants across the NESCAUM region including the member states, NJ and NY as well as the west coast state of OR. The differences between female and male respondents for **Fuel cost savings** and interest in **ZEV technology** are such that while there is a clear 1-2 ordering of these two motivations across all jurisdiction among female participants, for male participants these two are (statistically) tied.

Further, on average female participants score both the environmental motivations—**Climate change** and **Air quality**—higher than male respondents. Statistically significantly higher scores for female participants are more pervasive for **Climate change** (CA, OR, MD, and NY) than for **Air quality** (CA and OR). Statistically significantly higher mean scores for women on these environmental issues are nearly as pervasive as the statistically significantly higher scores for interest in **ZEV technology** are for men.

Though it ranked only as a statistical tie for fifth place (with **Safety compared to ICEVs** and **Home charge convenience**) across all participants, the pro-ZEV motivation **Fun to drive** also had higher scores for male than female participants across multiple states: CA, NJ, and NESCAUM. This difference is such that for male respondents across all geographies **Fun to drive** rises to a tie for third most highly scored motivation with climate and air quality.

Among those who designed their next vehicle to be a conventional or hybrid vehicle the motivations to not design a ZEV with the highest mean score across female and male participants in all jurisdictions was **Limited charging/fueling networks** for ZEVs. Not only is this the highest mean score across all participants everywhere in these data, but there is no difference anywhere between female and male respondents on this point. Across all participants, the other top scoring motivations against selecting a ZEV are **Purchase cost**, **Unfamiliar [ZEV] technology**, the effect of PEVs on the **Electricity supply**, and driving **Range**.

Purchase cost is similar to **Limited charging/fueling networks** in that it is highly scored by female and male participants across state or region. The only statistically significant difference by participant sex is a higher mean score for male than female respondents in DE.

Female participants in NJ, and the NESCAUM region join those in CA in scoring **Unfamiliar technology** statistically significantly higher, on average, than do their male counterparts. In a way, different evaluations of ZEV technology by female and male participants who don't select a ZEV amplify the distinction. While waiting for ZEV technology to become more reliable (**Technology unreliable**) is far from the top of the list of motivations against ZEVs for either female or male respondents, on average female respondents do assign it a statistically significantly higher score than do male respondents. Taking **Unfamiliar technology** and **Technology unreliable** together, in seven of the five jurisdictions female participants who do not select a ZEV seem more wary of ZEV technology than male participants who do not select a ZEV.

Table 10. Statistical Significance of Differences between Female (orange) and Male (green) Mean Non-ZEV Motivations by State and Region

Motivation against Designing and Selecting a ZEV:	*p*-value of test for difference between mean score for female and male participants									Global Mean Score
	CA	DE	MA	MD	NES	NJ	NY	OR	WA	
Limited charging or fueling network										2.8
Purchase cost		0.02								2.2
Unfamiliar technology	0.00				0.00	0.01				2.0
Electricity supply	0.03				0.03				0.01	1.8
Range	0.00			0.01					0.02	1.8
Charging duration									0.04	1.5
No home charging	0.02								0.01	1.4
Maintenance cost				0.01			0.05			1.3
Technology unreliable			0.01					0.04		1.0
Battery concerns	0.02									1.0
Charging cost	0.03	0.03							0.00	1.0
Higher incentives									0.01	1.0
Vehicle safety		0.01	0.01	0.02						0.9
Lifestyle (mis)fit	0.05			0.02						0.7
Vehicle appearance							0.02			0.5
Charging safety	0.02		0.01							0.5
Environmental concerns						0.05				0.3
Impression on peers					0.01	0.05				0.2

No difference between female and male participants' motivations *against* selecting a ZEV is as pervasive as the most pervasive differences in motivations *for* designing a ZEV. The most pervasive differences among the top scoring motivations against designing a ZEV are **Unfamiliar technology** (CA, NJ, and NESCAUM), **Electricity supply** (CA, WA, and NESCAUM), and **Range** (CA, WA, and MD).

Discussion Conclusion

This report examines the role of gender in prospective interest in EVs among new-car buying households across U.S. states with varying levels of EV market development and supporting policies. It reprises an analysis for CA [1] which serves as the comparative high ZEV market and policy support context. Here, new state-level analyses are presented for seven more U.S. states. Further, three of these seven are also included with five more states (for which there are no state-level analyses) in a regional analysis of the northeast U.S. The purpose is to assess whether results from CA extend to states with varying but generally lower ZEV market activity and less supportive policy contexts.

The overall conclusion is male respondents show slightly greater prospective interest in ZEVs than female participants across the observed state-level policy contexts but nowhere does the difference approach the three-to-one (or greater) skew toward males observed in new ZEV sales and registration data. While CA has the most supportive ZEV policy and largest ZEV market, the variation in results across the other states suggest only that as of late-2014 the observable variation in state-level policies and ZEV markets are not associated with different levels of prospective interest in ZEVs between female and male respondents. If there is any relationship between prospective interest in ZEVs across all the states analyzed here it is that interest among both female and male respondents is higher in west-coast states of CA, OR, and WA that saw earlier PEV sales than in the east coast states. However, nothing about the limited differences in prospective interest in ZEVs between female and male survey participants in late-2014 rises to the level of, or explains, the large disparity in the participation of women and men in the actual market for ZEVs that existed when these data were collected and continues to this day. Explanations for the ongoing disparity may lie in factors not accounted for here. These include limited body styles of ZEVs in the real world compared to the ubiquitous availability of body styles within the survey's vehicle design games and the actual experience of shopping for and buying cars. The results of this report argue we may remove "differences in policy and market contexts" from the list of things we are reasonably sure are the cause of differences between women and men in observed ZEV sales.

Prospective interest in ZEVs—measured as differences in the design and selection of a conventional ICEV, HEV, PHEV, BEV, or FCEV as a plausible next new vehicle for the household—is not statistically significantly related to participants' sex across most contexts analyzed here; the exceptions are NY and the aggregate of states that comprise the NESCAUM region (which includes NY). In multivariate models for each of these two, the parameter estimates for a binary sex identifier indicates that holding all other variables in the model constant, female participants were more likely to design ZEVs than male respondents. (This does not contradict the observation that more male than female respondent design ZEVs in NY as not all else is constant.) The same generalization holds for the NESCAUM region whether data from NY are included or not. However, since the coefficient for participants' sex identifier is not statistically significant in the models for MA or NJ, the same generalization does not hold for the other two most-populous states in the NESCAUM region. MA may be judged to have had a more supportive policy context than NY as MA offered a consumer ZEV purchase rebate while NY did not. NJ's ZEV policies were similar to those in NY. In brief, a sex-based difference is observed in the NY context, but not in the NJ or MA other contexts—the first similarly supportive of ZEVs as NY's context and the second more supportive of ZEVs.

In addition to a binary sex identifier, an additional variable representing interaction between that variable with another explanatory variable is statistically significant in the NY and NESCAUM models. Additional lines of inquiry into the differences between female and male participants in NY and NESCAUM come from these interaction effects. In NY, participants' monthly driving distances have a different effect among female vs. male participants. For NY, one possibility is the result is due to an overwhelming influence New York City might have on results for New York state: was there something about women's vs. men's vehicle ownership and daily travel in a large metropolis that allowed women to be—slightly—more open to the possibility of ZEVs than men? This seems less likely given the result for the NESCAUM region—which does not include this same interaction of participant sex identifier with monthly driving distance—since this interaction is also absent from the model for the two other NESCAUM states with the largest urban agglomerations: MA and NJ.

In the NESCAUM model, the interaction between participant sex and participants' evaluation of the relative safety and reliability of PEVs compared to conventional vehicles is statistically significant. The interaction effect in the NESCAUM model indicates the probability female participants' selected ZEVs was more sensitive to their assessments of whether PEVs are as safe and reliable as conventional gasoline vehicles than were the selections of male participants. The following thread of assumptions and additional information may be consistent with the result of the NESCAUM model:

- If perceptions of comparative safety or reliability of PEVs vis-à-vis conventional gasoline vehicles depend on cold weather performance; and,
- As women may be more attuned to safety and reliability in their vehicle choices than men; and,
- As PEVs' driving range is more noticeably affected by cold temperatures than is that of conventional or hybrid vehicles [14, 15]; and,
- As the NESCAUM region, broadly speaking, experiences colder winter temperatures than the Pacific Coast states in the study (CA, OR, and WA) and especially their larger urban centers; then,
- Female participants across the NESCAUM region—who are estimated to be more likely than men to design a PEV as their next new vehicle (the main effect of **Participant sex**)—are more sensitive to the effects of cold weather on their perceptions of the safety and reliability of PEVs vis-à-vis conventional gasoline vehicles (the interaction between **Participant sex** and **Prior PEV evaluation factor: safety, reliability**).

This line of reasoning is suppositional and subject to further research into at least three points:

1. The line of reasoning depends on PEV cold weather performance being common knowledge.
2. Do perceptions of comparative safety or reliability of PEVs vis-à-vis conventional gasoline vehicles include cold weather performance?
3. Are women more attuned to safety and reliability in all their vehicle choices than men?

At least in terms of their motivations, participants across all jurisdictions in this study (including those in CA) who expressed positive prospective interest in ZEVs are broadly like actual ZEV owners across a diverse set of ZEV market and policy contexts. These same widely held motivations have been reported among PEV owners in CA [19], Norway (often touted as the most supportive PEV policy context anywhere in the world) [20], and across the Nordic countries more generally which are often taken to be examples of gender equality [21]. Among the survey participants who design a ZEV, the two most compelling motivations across all states and regions and across women and men are fuel costs savings and positive interest in ZEV technology. For fuel cost savings, the mean score for females is higher than for males in all states and the NESCAUM region—though only in MD, NESCAUM, and OR is the difference large enough to be statistically significant. For positive interest in ZEV technology, everywhere except DE, the mean score for male participants is higher than for females. The difference is large enough to be statistically significant in NESCAUM, NJ, NY, and OR, as it was in CA. The next two high scoring motivations for selecting a ZEV relate to "environmental" issues: air quality and climate change. Females and males both scored statements about reducing the effect of their driving on air quality and climate change as above average motivations. However, females scored climate change statistically significantly higher than males in four states and air quality higher than males in two of those four.

Among those who did not design a ZEV for their household, the leading demotivation's were limited electric charging network and vehicle purchase cost. These were top scored in all states, with no significant difference between the sexes except for purchase price in DE where male respondents scored vehicle purchase cost as a more important demotivation to selecting a ZEV.

Perceptions of ZEV technology are motivating and demotivating in ways that reinforce distinctions between female and male participants: while interest in ZEV technology attracts disproportionately more male respondents to ZEVs, unfamiliarity with ZEV technology repels disproportionately more women. Though highly scored by all participants everywhere who did not select a ZEV, female respondents in CA, NJ, and across the NESCAUM region scored unfamiliar ZEV technology higher as a motivation to not design a ZEV than their male counterparts.

The models used here are probabilistic and their results are interpreted as such. Every statement phrased here as "female participants are more likely than male" (and vice versa) is intended to include female and male participants. Female participants who select a ZEV scored environmental motivations higher on average than their male counterparts. Still, many of their male counterparts are similarly motivated by environmental beliefs. Female respondents who do not select a ZEV scored unfamiliar technology as a motivation against ZEVs higher on average than their male counterparts. Still, many male participants were also dissuaded by unfamiliar ZEV technology. As such, the results here are not categorical despite the use of a binary sex indicator as a proxy for gender.

The analyses here use data collected at the end of 2014. These may seem out-of-date and certainly the market and policy contexts in all these states have changed since 2014. More ZEVs have been sold. A greater variety of makes and models of ZEVs—PEVs mostly—are offered for sale. More PEV charging infrastructure has been built as has hydrogen fueling infrastructure (though this is still sparse and limited almost solely to CA). More states are offering vehicle purchase incentives. There are even more states with ZEV requirements now as Colorado adopted such in 2019. However, as evidenced in this report the strong skew toward men in the EV market up to late-2014 had not diminished through 2018. It seems unlikely to have diminished since 2018 given the extent to which the one vehicle dominating EV sales since then, the Tesla Model 3, has been described as, “the most ‘male’ of Tesla’s models” [6]. Only by looking at older data on new car buyers’ prospective interest in ZEVs can it be seen today that over the course of several years policy and markets have yet to turn the similar prospective interest in ZEVs of female and male participants into parity in observed new vehicle sales and registrations, or even a trend toward parity.

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Data Management

Products of Research

Data were collected in late 2014 and early 2015 under contract with the California Air Resources Board and Northeast States for Coordinated Air Use Management. Data were collected via an online survey and in-home interviews of new-car buying households. There are eight state-level data sets: California, DE, MD, MA, NJ, NY, OR, and WA. A ninth data set covers the region defined by NESCAUM: CT, ME, MA, NH, NJ, NY, RI, and VT. The versions of these nine data sets required to reproduce the analysis reported here are archived for public use.

Data Format and Content

All of the data are available from a single URL: https://doi.org/10.25338/B80P8D. Two data files are available for each of the nine states for a total of 18 data files. Files with the .jmp suffix are proprietary to the JMP© statistics program from SAS Institute. These files contain data and notes about variable coding, value ordering, and other information. CSV files are generally accessible for import into a wide variety of analytical software but contain no explanatory notes. The full list of individual data files is below in Reuse and Redistribution.

Further, an annotated version of the on-line questionnaire is available in the original report from California [7]. The on-line instrument is customized to each respondent as they complete it. More than simple skip patterns as respondents answer questions content of subsequent questions is populated with either the information they provide or based on such information. Some of this requires calls to data external to the survey instrument; some of these data are proprietary and some are no longer available. Given these, no "live" version of the on-line questionnaire from 2014 is still maintained. The annotated version and the description of the survey provided in the linked report are provided to assist data users.

Data Access and Sharing

The data used for the analyses in this report are available on the Dryad repository website at https://doi.org/10.25338/B80P8D.

Reuse and Redistribution

These data are accessible to the public and open for reuse and redistribution for non-commercial purposes. Any use of one or more shall be made with appropriate citation:

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Appendix: State and Regional Model Results

Table A1. CA base model of respondent drivetrain design

Whole Model Test

Model	-LogLikelihood	DF	Chi-Square	Prob. > ChiSq
Difference	375.6638	112	751.3276	<.0001
Full	2047.6542			
Reduced	2423.318			

Lack of Fit

Source	DF	-LogLikelihood	Chi-Square
Lack of Fit	6524	2047.6542	4095.308
Saturated	6636	0	**Prob. > ChiSq**
Fitted	112	2047.6542	1.000

Effect Likelihood Ratio Tests

Source	DF	Likelihood Ratio Chi-Square	Prob. > ChiSq
Electricity a likely replacement for gas/diesel	4	31.4484	<0.0001
Hydrogen a likely replacement for gas/diesel	4	10.2745	0.0360
Home PEV charging access	12	32.6172	0.0011
Access to natural gas at residence	4	10.3377	0.0351
Familiarity factor: HEV, BEV, PHEV, FCEV	4	12.9593	0.0115
Familiarity factor: ICEV	4	15.7699	0.0033
Driving experience factor: BEV, PHEV, FCEV	4	15.0889	0.0045
Driving experience factor: HEV	4	18.3296	0.0011
Prior PEV evaluation factor: safety, reliability	4	11.5805	0.0208
Prior PEV evaluation factor: range, fueling/charging duration	4	13.4185	0.0094
Prior FCEV evaluation factor: range, fueling/charging duration	4	12.2441	0.0156
Prior consideration of PEVs	12	52.0769	<0.0001
Prior consideration of FCEVs	12	26.7271	0.0085
Should government offer incentives	16	30.9529	0.0136
Seen public charges for PEV	4	9.4452	0.0509
Participant's own interest in ZEV technology	12	40.0566	<0.0001
Environmental concerns factor: personal worry about air quality, air pollution is a regional health threat	4	22.5082	0.0002

Table A2. CA Model Tests: base model, base model + sex, and base model + sex + selected cross-effects of sex and other explanatory variables

	R^2	AIC_C	BIC	DF
Base model	0.1549	4356.18	4967.33	112
Base + Respondent sex	**0.1564**	***4337.96***	**4968.76**	**116**
Base + Respondent sex + Respondent sex crossed by the following, one at a time:				
Electricity is a likely replacement for gasoline and diesel	0.1578	4340.76	4991.88	120
Home PEV charging access	0.1590	4353.67	5045.30	128
Familiarity factor: HEV, BEV, PHEV, FCEV	0.1571	4344.02	4995.14	120
Familiarity factor: ICEV	**0.1584**	***4337.71***	**4988.83**	**120**
Driving experience factor: HEV	0.1566	4346.48	4997.6	120
Prior PEV evaluation factor: safety, reliability	0.1578	4340.35	4991.47	120
Prior PEV evaluation factor: range, fueling/charging duration	0.1572	4343.61	4994.74	120
Prior consideration of PEVs	0.1591	4353.18	5044.82	128
Participant's own interest in ZEV technology	0.1603	4347.39	5039.02	128
Environmental concerns factor: personal worry about air quality, air pollution is a regional health threat	0.1566	4346.38	4997.5	120

Table A3. DE base model of respondent drivetrain design

Whole Model Test				
Model	**-LogLikelihood**	**DF**	**Chi-Square**	**Prob. > ChiSq**
Difference	42.55691	32	85.11382	<.0001
Full	214.03516			
Reduced	256.59207			

Lack of Fit			
Source	**DF**	**-LogLikelihood**	**Chi-Square**
Lack of Fit	232	82.53231	165.0646
Saturated	264	131.50284	**Prob. > ChiSq**
Fitted	32	214.03516	1.000

Effect Likelihood Ratio Tests			
Source	**DF**	**Likelihood Ratio Chi-Square**	**Prob. > ChiSq**
Participant's own interest in ZEV technology	12	19.6647	0.0737
Electricity a likely replacement for gas/diesel	4	9.2435	0.0553
Awareness for incentives from the federal or state government to buy and drive alternative fuel vehicles	8	19.4547	0.0126
Home PEV charging access	4	9.1491	0.0575
Prior consideration of PEVs	4	13.9902	0.0073

Table A4. DE Model Tests: base model, base model + sex, and base model + sex + cross-effects of sex and other explanatory variables

	R^2	AIC_C	BIC	DF
Base model	0.1659	516.414	618.81	32
Base + Participant sex	0.1743	524.389	635.692	36
Base + Participant sex + Participant sex crossed by the following, one at a time:				
Participant's own interest in ZEV technology	0.1950	554.600	688.616	48
Electricity a likely replacement for gas/diesel	0.1796	534.587	654.164	40
Awareness for incentives from the federal or state government to buy and drive alternative fuel vehicles	0.1910	542.301	669.468	44
Home PEV charging access	0.1842	532.207	651.785	40
Prior consideration of PEVs	0.1821	533.284	652.861	40

Table A5. MD base model of respondent drivetrain design

Whole Model Test				
Model	**-LogLikelihood**	**DF**	**Chi-Square**	**Prob. > ChiSq**
Difference	56.29045	16	112.5809	<.0001
Full	347.66712			
Reduced	403.95757			

Lack of Fit			
Source	**DF**	**-LogLikelihood**	**Chi-Square**
Lack of Fit	1068	332.19421	664.3884
Saturated	1084	15.47291	**Prob. > ChiSq**
Fitted	16	347.66712	1.000

Effect Likelihood Ratio Tests			
Source	**DF**	**Likelihood Ratio Chi-Square**	**Prob. > ChiSq**
Air pollution is a regional health threat	4	22.0163	0.0002
Prior consideration of PEVs	8	63.9215	<.0001
Enough places to charge electric vehicles	4	9.3009	0.054

Table A6. MD Model Tests: base model, base model + sex, and base model + sex + cross-effects of sex and other explanatory variables

	R^2	**AIC_C**	**BIC**	**DF**
Base model	0.1393	738.422	808.938	16
Base + Participant sex	0.1420	745.697	829.544	20
Base + Participant sex + Participant sex crossed by the following, one at a time:				
Air pollution is a regional health threat	0.1491	759.544	869.186	28
Prior consideration of PEVs	0.1443	753.463	850.357	24
There are enough places to charge electric vehicles	0.1470	751.292	848.185	24

Table A7. MA base model of respondent drivetrain design

Whole Model Test

Model	-LogLikelihood	DF	Chi-Square	Prob. > ChiSq
Difference	135.49043	56	270.9809	<.0001
Full	526.14569			
Reduced	661.63612			

Lack of Fit

Source	DF	-LogLikelihood	Chi-Square
Lack of Fit	1916	524.7594	1049.519
Saturated	1972	1.38629	**Prob. > ChiSq**
Fitted	56	526.14569	1.000

Effect Likelihood Ratio Tests

Source	DF	Likelihood Ratio Chi-Square	Prob. > ChiSq
Hydrogen a likely replacement for gas/diesel	4	17.9695	0.0013
Home PEV charging access	12	25.5218	0.0125
Electricity installation authority at residence	4	15.2857	0.0041
Seen public charges for PEV	4	23.8187	<.0001
Prior consideration of PEVs	12	32.6521	0.0011
Prior consideration of FCEVs	12	29.5419	0.0033
Prior PEV evaluation factor: safety, reliability	4	18.1819	0.0011
Environmental concerns factor: air quality personal worry, regional health threat, amenable to lifestyle change; global warming evidence, climate change, concern	4	16.2328	0.0027

Table A8. MA Model Tests: base model, base model + sex, and base model + sex + cross-effects of sex and other explanatory variables

	R^2	AIC_C	BIC	DF
Base model	0.2048	1189.12	1424.69	56
Base + Participant sex	0.2087	1194.38	1444.3	60
Base + Participant sex + Participant sex crossed by the following, one at a time:				
Hydrogen is a likely replacement for gasoline and diesel	0.2118	1200.96	1465.03	64
Home PEV charging access	0.2180	1214.72	1506.48	72
Electricity installation authority at residence	0.2122	1200.45	1464.52	64
Seen public charges for PEV	0.2114	1201.52	1465.59	64
Prior consideration of PEVs	0.2182	1214.42	1506.19	72
Prior consideration of FCEVs	0.2194	1212.94	1504.71	72
Prior PEV evaluation factor: safety, reliability	0.210	1203.34	1467.41	64
Environmental concerns factor: air quality personal worry, regional health threat, amenable to lifestyle change; global warming evidence, climate change concern	0.2123	1200.37	1464.44	64

Table A9. NESCAUM base model of respondent drivetrain design

Whole Model Test

Model	-LogLikelihood	DF	Chi-Square	Prob. > ChiSq
Difference	567.7489	152	1135.498	<.0001
Full	2609.7248			
Reduced	3177.4737			

Lack of Fit

Source	DF	-LogLikelihood	Chi-Square
Lack of Fit	9312	2609.7248	5219.45
Saturated	9464	0	**Prob. > ChiSq**
Fitted	152	2609.7248	1.000

Effect Likelihood Ratio Tests

Source	DF	Likelihood Ratio Chi-Square	Prob. > ChiSq
Participant education	16	24.8047	0.0733
Participant's own interest in ZEV technology	12	57.2198	<.0001
Participant sex	4	15.6559	0.0035
Environmental concerns factor: air quality personal worry, regional health threat, amenable to lifestyle change; global warming evidence, climate change concern	4	26.2823	<.0001
Environmental concerns factor: comparative environmental and health risks posed by BEVs and ICEVs	4	10.3096	0.0355
Prior PEV evaluation factor: range, fueling/charging duration, purchase price	4	3.7323	0.4435
Prior PEV evaluation factor: safety, reliability	4	14.5689	0.0057
Prior PEV evaluation factor: home charging, presence of public PEV chargers	4	7.8153	0.0986
Driving experience factor: HEV	4	24.7932	<.0001
Familiarity factor: ICEV	4	26.3944	<.0001
Prior consideration of PEVs	16	65.4056	<.0001
Prior consideration of FCEVs	12	31.0146	0.002
Should government offer incentives	16	22.1873	0.1372
Park at least one vehicle in a garage or carport at home	4	11.3299	0.0231
Participant commutes to a workplace	4	8.7509	0.0676

Continued on next page.

Effect Likelihood Ratio Tests **Source**	**DF**	**Likelihood Ratio Chi-Square**	**Prob. > ChiSq**
Electricity a likely replacement for gas/diesel	4	4.8233	0.3059
Hydrogen a likely replacement for gas/diesel	4	25.7953	<.0001
Seen public PEV chargers	16	39.6467	0.0009
Household income	4	4.8591	0.3021
Prior FCEV evaluation factor: range, fueling/charging duration, (minus of) presence of public chargers	4	3.4106	0.4916
Prior FCEV evaluation factor: safety, reliability	4	1.2054	0.8772
Prior FCEV evaluation factor: purchase price	4	1.3033	0.8608

Table A10. NESCAUM Model Tests: base model and base model + cross-effects of sex and other explanatory variables

	R^2	AIC_C	BIC	DF
Base model	0.1787	5553.58	6431.67	152
Base + Participant sex crossed by the following, one at a time:				
Participant education	0.1813	5574	6539.46	168
Participant's own interest in ZEV technology	0.18	5572.84	6516.51	164
Environmental concerns factor: personal worry about air quality, air pollution is a regional health threat, air pollution can be reduced if individuals make changes in their lifestyle, climate change, global warming, urgent national need	0.179	5560.67	6460.65	156
Environmental concerns factor: comparison of the possessed environmental risk by BEV and ICEV, comparison of the possessed health risk by BEV and ICEV	0.1791	5560.14	6460.13	156
Prior PEV evaluation factor: range, fueling/charging duration, purchase price	0.1792	5559.16	6459.14	156
Prior PEV evaluation factor: safety, reliability	**0.1805**	***5550.94***	**6450.92**	**156**
Prior PEV evaluation factor: presence of home charger, presence of public chargers	0.1792	5559.45	6459.43	156
Driving experience factor: HEV	0.1797	5555.99	6455.97	156
Familiarity factor: ICEV	0.1795	5557.34	6457.32	156
Prior consideration of PEVs	0.1825	5566.31	6531.78	168
Prior consideration of FCEVs	0.1818	5561.38	6505.05	164
Should government offer incentives	0.1817	5571.21	6536.68	168
Park at least one vehicle in a garage or carport at home	0.1787	5562.37	6462.35	156
Participant commutes to a workplace	0.1794	5558.49	6458.47	156
Electricity is a likely replacement for gasoline and diesel	0.179	5560.72	6460.7	156
Hydrogen is a likely replacement for gasoline and diesel	0.179	5560.47	6460.45	156
Seen public charges for PEV	0.1808	5576.87	6542.33	168
Household income	0.1788	5561.92	6461.9	156
Prior FCEV evaluation factor: range, fueling/charging duration, (minus of) presence of public chargers	0.1793	5558.92	6458.9	156
Prior FCEV evaluation factor: safety, reliability	0.1793	5559.03	6459.01	156
Prior FCEV evaluation factor: purchase price	0.1791	5560.09	6460.07	156

Table A11. NJ base model of respondent drivetrain design

Whole Model Test				
Model	**-LogLikelihood**	**DF**	**Chi-Square**	**Prob. > ChiSq**
Difference	145.90901	72	291.818	<.0001
Full	489.04431			
Reduced	634.95332			
Lack of Fit				
Source	**DF**	**-LogLikelihood**	**Chi-Square**	
Lack of Fit	1888	489.04431	978.0886	
Saturated	1960	0	**Prob. > ChiSq**	
Fitted	72	489.04431	1.000	

Effect Likelihood Ratio Tests			
Source	**DF**	**Likelihood Ratio Chi-Square**	**Prob. > ChiSq**
Participant’s own interest in ZEV technology	12	23.5430	0.0235
Prior consideration of PEVs	12	37.0779	0.0002
Should government offer incentives	16	30.1078	0.0175
Awareness for incentives from the federal or state government to buy and drive alternative fuel vehicles	8	15.9375	0.0433
Prior PEV evaluation factor: safety, reliability	4	20.8092	0.0003
Driving experience factor: HEV PHEV	4	14.3567	0.0062
Seen public charges for PEV	4	7.6945	0.1034
Familiarity factor: ICEV	4	20.9133	0.0003
Participant commutes to a workplace	4	8.7943	0.0665
Hydrogen a likely replacement for gas/diesel	4	13.4011	0.0095

Table A12. NJ Model Tests: base model, base model + sex, and base model + sex + cross-effects of sex and other explanatory variables

	R^2	AIC_C	BIC	DF
Base model	0.2298	1158.36	1449.02	72
Base + Participant sex	0.2327	1165.96	1470.07	76
Base + Participant sex + Participant sex crossed by the following, one at a time:				
Participant's own interest in ZEV technology	0.2381	1194.6	1537.67	88
Prior consideration of PEVs	0.2419	1189.69	1532.76	88
Should government offer incentives	0.2403	1204.06	1559.65	92
Awareness for incentives from the federal or state government to buy and drive alternative fuel vehicles	0.2427	1176.63	1506.95	84
Prior PEV evaluation factor: safety, reliability	0.2364	1172.84	1490.17	80
Driving experience factor: HEV PHEV	0.2333	1176.82	1494.15	80
Seen public charges for PEV	0.2389	1169.68	1487.01	80
Familiarity factor: ICEV	0.2355	1173.99	1491.32	80
Participant commutes to a workplace	0.234	1175.87	1493.2	80
Hydrogen a likely replacement for gas/diesel	0.2394	1169.1	1486.43	80

Table A13. NY base model of respondent drivetrain design

Whole Model Test				
Model	**-LogLikelihood**	**DF**	**Chi-Square**	**Prob. > ChiSq**
Difference	154.906	36	309.812	<.0001
Full	915.9204			
Reduced	1070.8264			

Lack of Fit			
Source	**DF**	**-LogLikelihood**	**Chi-Square**
Lack of Fit	3056	907.07943	1814.159
Saturated	3092	8.84101	**Prob. > ChiSq**
Fitted	36	915.92045	1.000

Effect Likelihood Ratio Tests			
Source	**DF**	**Likelihood Ratio Chi-Square**	**Prob. > ChiSq**
Participant sex	4	12.7970	0.0123
Participant's own interest in ZEV technology	4	46.0329	<.0001
Participant's vehicle's monthly miles	4	14.8781	0.005
Seen public charges for PEV	4	18.5975	0.0009
Prior consideration of PEVs	8	39.6326	<.0001
Prior consideration of FCEVs	8	18.7250	0.0164
Personal worry about air quality	4	24.1187	<.0001

Table A14. NY Model Tests: base model and base model + cross-effects of sex and other explanatory variables

	R^2	AIC_C	BIC	DF
Base model	0.145	1916.2	2098.8	36
Base + Participant sex crossed by the following, one at a time:				
Participant's own interest in ZEV technology	0.146	1922.5	2122.8	40
Participant's vehicle's monthly miles	**0.153**	***1908.5***	**2108.8**	**40**
Seen public charges for PEV	0.147	1919.6	2119.9	40
Prior consideration of PEVs	0.152	1919	2137	44
Prior consideration of FCEVs	0.151	1920.5	2138.5	44
Personal worry about air quality	0.147	1920.7	2121	40

Table A15. OR base model of respondent drivetrain design

Whole Model Test

Model	-LogLikelihood	DF	Chi-Square	Prob. > ChiSq
Difference	101.59243	48	203.1849	<.0001
Full	419.60394			
Reduced	521.19636			

Lack of Fit

Source	DF	-LogLikelihood	Chi-Square
Lack of Fit	1392	419.60394	839.2079
Saturated	1440	0	**Prob. > ChiSq**
Fitted	48	419.60394	1.000

Effect Likelihood Ratio Tests

Source	DF	Likelihood Ratio Chi-Square	Prob. > ChiSq
Participant’s vehicle fuel spending per month	4	12.9314	0.0116
Electricity a likely replacement for gas/diesel	4	11.4740	0.0217
Familiarity factor: HEV, BEV, PHEV, FCEV	4	12.8974	0.0118
Prior PEV evaluation factor: safety, reliability	4	12.8727	0.0119
Prior consideration of PEVs	4	25.1146	<.0001
Participant’s vehicle’s fuel economy	4	9.0280	0.0604
Price paid for most recently acquired new vehicle	4	12.6623	0.013
Environmental concerns factor: air quality personal worry, regional health threat, amenable to lifestyle change; global warming evidence, climate change concern	4	9.7090	0.0456
Participant commutes to a workplace	4	8.7426	0.0679
Flexibility as to who drives which vehicle	12	31.8473	0.0015

Table A16. OR Model Tests: base model, base model + sex, and base model + sex + cross-effects of sex and other explanatory variables

	R^2	AIC_C	BIC	DF
Base model	0.1949	961.104	1145.43	48
Base + Participant sex	0.1969	970.112	1166.89	52
Base + Participant sex + Participant sex crossed by the following, one at a time:				
Participant’s vehicle fuel spending per month	0.2009	977.349	1186.28	56
Electricity a likely replacement for gas/diesel	0.2001	978.252	1187.18	56
Familiarity factor: HEV, BEV, PHEV, FCEV	0.1997	978.579	1187.51	56
Prior PEV evaluation factor: safety, reliability	0.1972	981.231	1190.16	56
Prior consideration of PEVs	0.203	975.232	1184.17	56
Participant’s vehicle’s fuel economy	0.1996	978.781	1187.71	56
Price paid for most recently acquired new vehicle	0.209	968.952	1177.88	56
Environmental concerns factor: air quality personal worry, regional health threat, amenable to lifestyle change; global warming evidence, climate change concern	0.1998	978.571	1187.5	56
Participant commutes to a workplace	0.1998	978.509	1187.44	56
Flexibility as to who drives which vehicle	0.2207	980.469	1212.78	64

Table A17. WA base model of respondent drivetrain design

Whole Model Test				
Model	**-LogLikelihood**	**DF**	**Chi-Square**	**Prob. > ChiSq**
Difference	161.88933	76	323.7787	<.0001
Full	487.4399			
Reduced	649.32922			

Lack of Fit			
Source	**DF**	**-LogLikelihood**	**Chi-Square**
Lack of Fit	1732	487.4399	974.8798
Saturated	1808	0	**Prob. > ChiSq**
Fitted	76	487.4399	1.000

Effect Likelihood Ratio Tests			
Source	**DF**	**Likelihood Ratio Chi-Square**	**Prob. > ChiSq**
Electricity a likely replacement for gas/diesel	4	14.8031	0.0051
Home PEV charging access	12	22.0958	0.0365
Seen public charges for PEV	4	8.2101	0.0842
Awareness for incentives from the federal or state government to buy and drive alternative fuel vehicles	8	21.1228	0.0068
Prior consideration of PEVs	16	32.0250	0.0099
Participant’s own interest in ZEV technology	4	14.1362	0.0069
Driving experience factor: HEV	4	29.0781	<.0001
Familiarity factor: HEV, BEV, PHEV, FCEV	4	8.2487	0.0829
Environmental concerns factor: personal worry about air quality, air pollution is a regional health threat	4	8.0022	0.0915
Prior PEV evaluation factor: safety, reliability	4	10.8602	0.0282
Body size of the new next vehicle	8	28.2373	0.0004
Participant’s vehicle’s monthly miles	4	8.2247	0.0837

Table A18. WA Model Tests: base model, base model + sex, and base model + sex + cross-effects of sex and other explanatory variables

	R^2	AIC_C	BIC	DF
Base model	0.2493	1169.72	1464.15	76
Base + Participant sex	0.2513	1179.11	1486.04	80
Base + Participant sex + Participant sex crossed by the following, one at a time:	0.2594	1180.85	1500.02	
Electricity a likely replacement for gas/diesel	0.2683	1194.58	1537.39	84
Home PEV charging access	0.2587	1181.77	1500.94	92
Seen public charges for PEV	0.2565	1197.08	1528.21	84
Awareness for incentives from the federal or state government to buy and drive alternative fuel vehicles	0.2598	1218.69	1572.89	88
Prior consideration of PEVs	0.252	1190.42	1509.58	96
Participant's own interest in ZEV technology	0.2541	1187.74	1506.9	84
Driving experience factor: HEV	0.2548	1186.83	1505.99	84
Familiarity factor: HEV, BEV, PHEV, FCEV	0.2536	1188.31	1507.47	84
Environmental concerns factor: personal worry about air quality, air pollution is a regional health threat	0.2559	1185.37	1504.53	84
Prior PEV evaluation factor: safety, reliability	0.2573	1196.01	1527.14	84
Body size of the new next vehicle	0.2539	1187.96	1507.13	88
Participant's vehicle's monthly miles	0.2493	1169.72	1464.15	84